Bloominton Industrial Park

LOGANSPORT [illegible] CULVERT CO.

LOGANSPORT, INDIANA

Phone [illegible]

PRICE LIST

1957

[illegible]

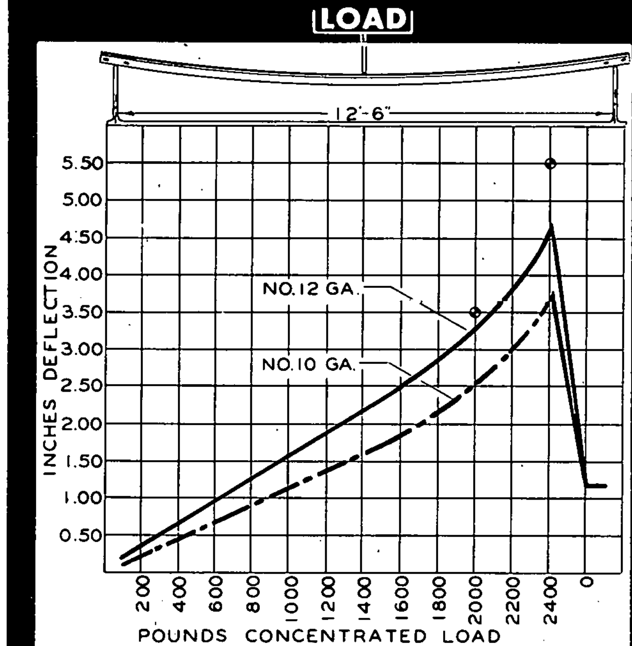
Sectional Plate Pipe and Pipe-Arch

Drainage Products

Guard Rail

BEAM RAIL TESTS

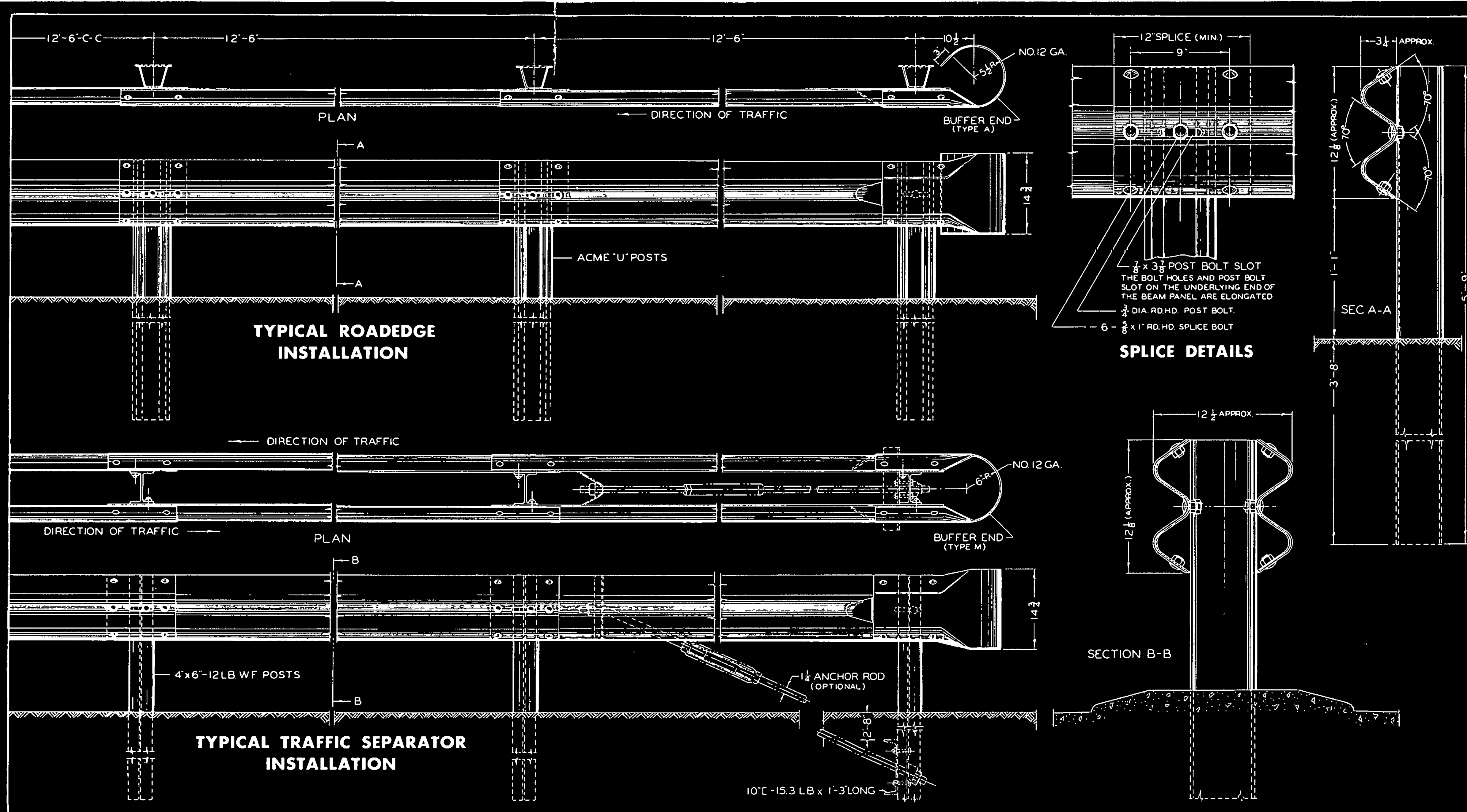
AASHO SPEC. No. 3.2.6

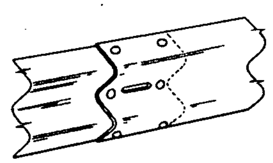


ACME BEAM GUARD SPECIFICATIONS

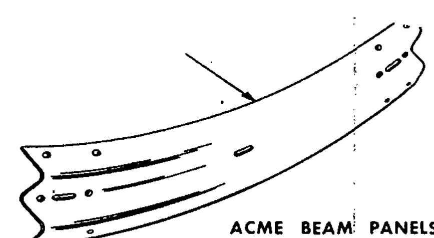
ACME PANEL 12" Wide (Min.) x 3"Deep (Min.)	10 GA. (.1345)	12 GA. (.1095)
CROSS SECTION AREA (Square Inches)	2.35	1.91
SECTION MODULUS (In.^{3})	1.602	1.304
TENSILE STRENGTH —THRU SPLICE	89,000	73,000
WEIGHT FOR 12'6" SPAN PANEL (LBS.)	107.8	87.6

Outstanding ACME Beam Guard *Features*

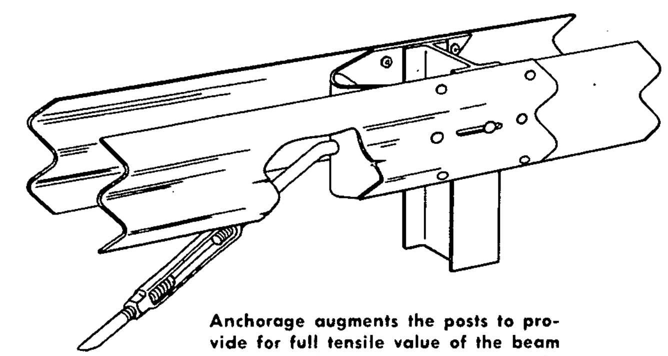




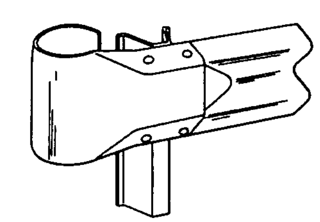
The ACME BEAM PANEL SPLICE has 12 inches minimum overlap secured with 6 hardened steel button head bolts and provides for a smooth connection and bend at the posts on sweeping curves.



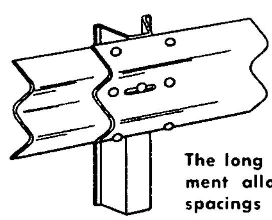
ACME BEAM PANELS are furnished precurved for inside and outside curves in any radius down to 9 feet. Extra post bolt slot at the center of curved panel is available on request.



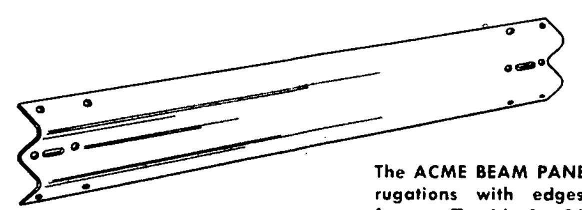
Anchorage augments the posts to provide for full tensile value of the beam rail assembly and thus prevents pocketing of the vehicle.



The ACME BUFFER END for both traffic separator and road edge guard cushions impact to provide maximum SAFETY.

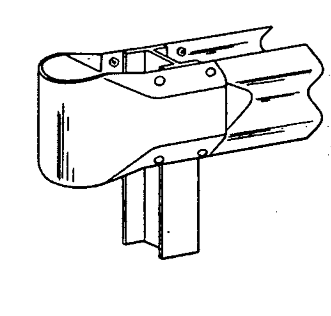


The long slot provided for post attachment allows for inaccuracies in post spacings and expansion - contraction movement of the rail assembly at the post connections.

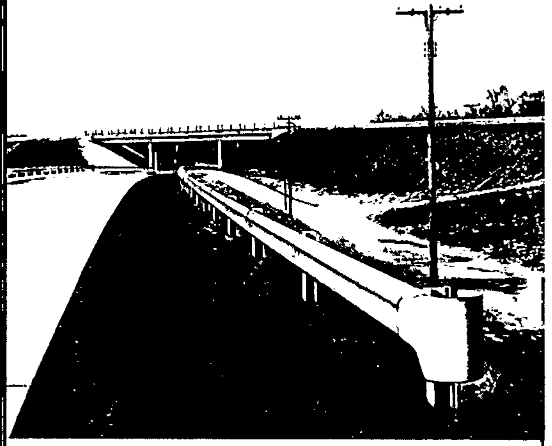


The ACME BEAM PANEL has deep corrugations with edges sloping back from traffic side for SAFETY to thrown occupants. The slope angles are self cleaning of dirt and road salt and tend to minimize painting problems. Maximum nestability of panels in shipping is assured with the ACME design.

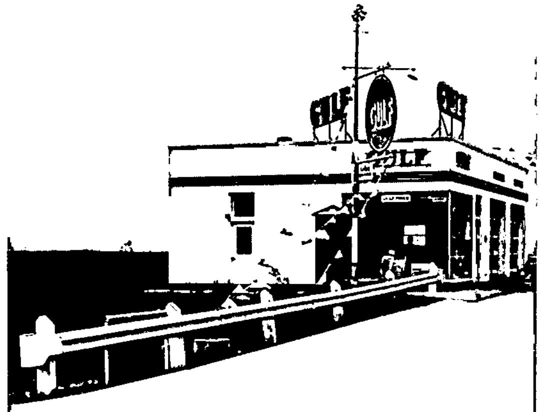
Panels and buffer ends are furnished, on order, in "Man-Ten" steel which provides 50% higher corrosion resistance and 20% higher impact strength than same gauge straight carbon steel.



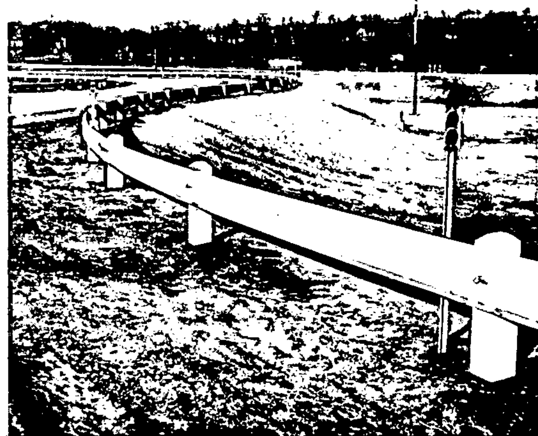
Picture Story TYPICAL ACME BEAM GUARD INSTALLATIONS



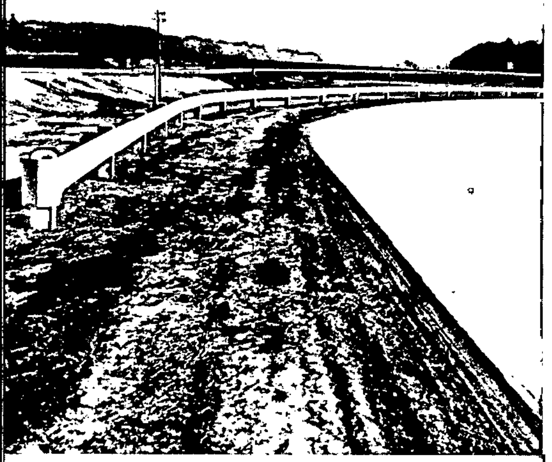
Channelizing of traffic is the effect on overpasses and underpasses with this typical ACME installation on heavily traveled Rt. 5s near Herkimer, N. Y.



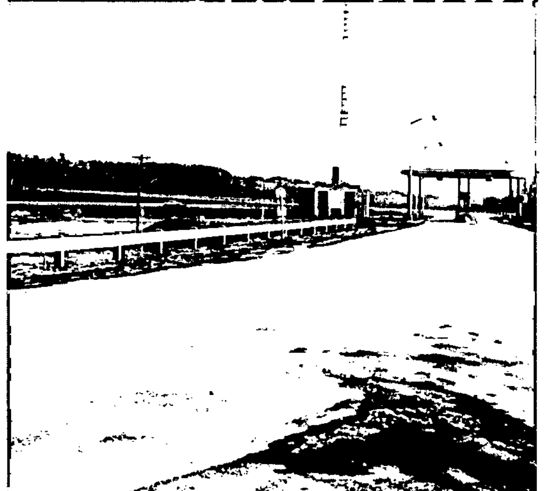
Gas stations, parking lots, dams, power installations, as well as highways can be delineated with ACME Beam Guards.



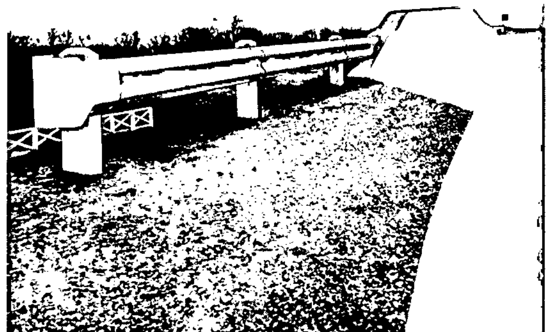
High strength safety on a sharp S Curve accomplished with an ACME installation.



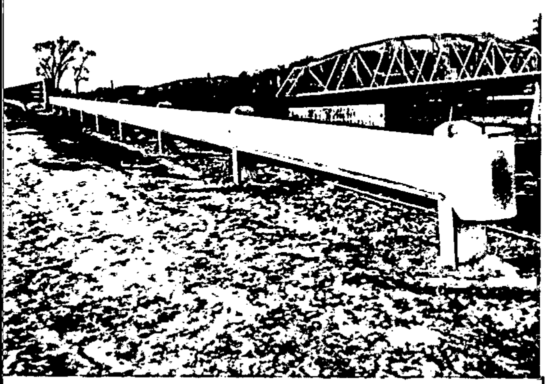
Safety is assured on this dangerous Hi-speed curve with ACME Beam Guard.



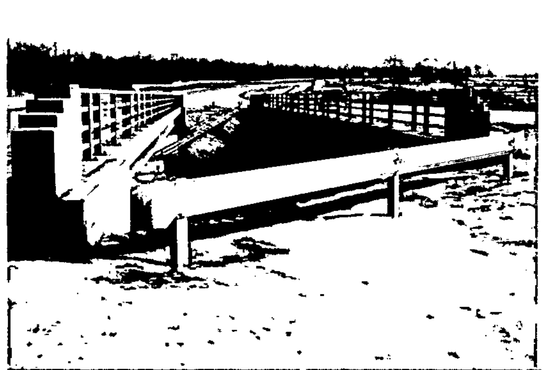
High visibility and protection is the result of an ACME installation at toll booths and interchanges.



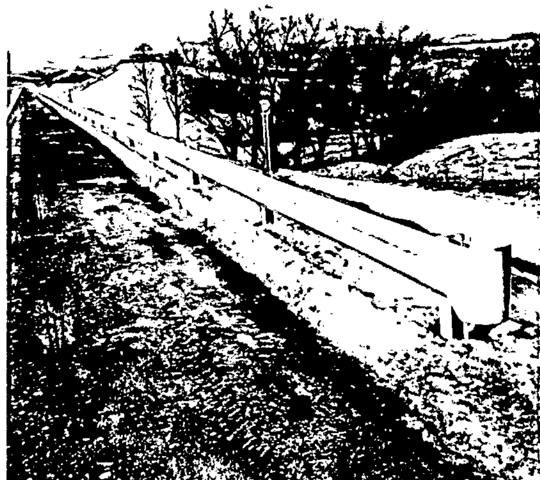
Ruggea and aesthetic beauty by use of wood posts and ACME smooth flowing functional design.



Rugged steel construction for maximum safety gives highway users that extra sense of security in day or night driving.



ACME Beam Guard versatility is demonstrated on this bridge opening to insure against a common danger area.



Mile after mile of smooth flowing ACME contours can be found on the New York State Thruway, the world's longest super highway.

ACME Beam Guard

ACME® HIGHWAY PRODUCTS CORPORATION

● "ACME", a name representing quality in highway construction materials, with over a quarter of a century of experience in development and testing of highway guards, is a name to be depended on.

Leading consulting engineers, State highway officials and technical personnel, have come to depend on "ACME" engineering know-how in the highway guard field. Acme Highway products can be found on the great thruways and expressways of our country.

For further information, write or contact our main office at Buffalo, N. Y.

Mfd. by ACME HIGHWAY PRODUCTS CORPORATION 33 Chandler St., Buffalo 7, N.Y.

Also Manufacturers of:

LONGITUDINAL JOINT SUPPORTS • TRANSVERSE CONTRACTION JOINT SUPPORTS

CABLE GUARD OFFSET SPRING BRACKETS AND FITTINGS

TRANSVERSE EXPANSION JOINT SUPPORTS

Form No. A355

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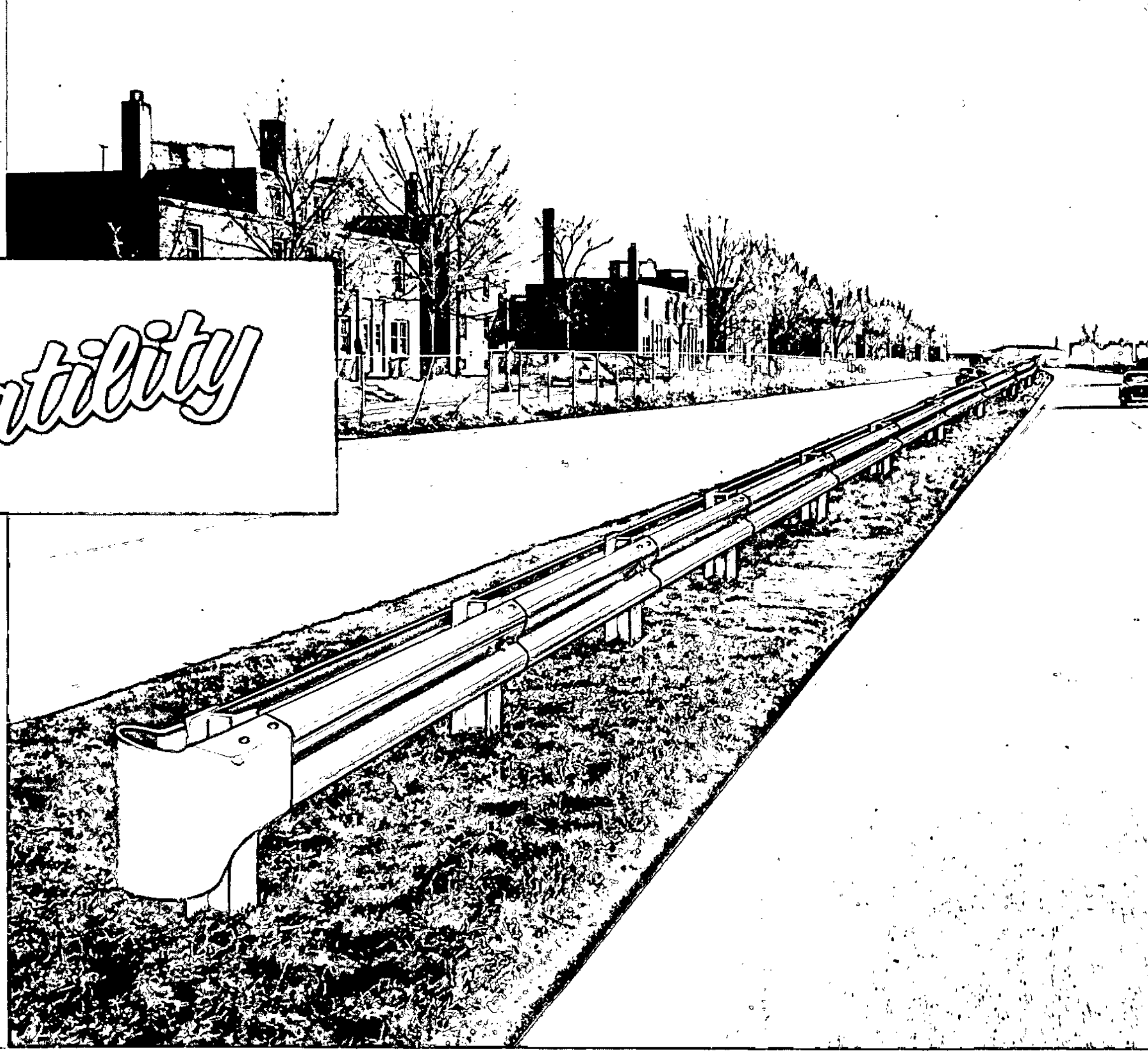
ACME *Versatility*



ACME Beam Guard panels are easily adapted to the Traffic Separator arrangement.

Problem

When the accident reports are tabulated, it's the head-on collision which does the most damage. Turnpike statistics show that more accident deaths are due to this condition than any other cause.

The killer type of accident can be eliminated from your road system. Dangerous curves can be made accident-free with economy while being re-designed for safety.

The death- free week-end can be closer to reality with a minimum of expenditure.

Solution

ACME's answer is the Traffic Separator or Center Mall Barrier Guard. Composed of rugged H section posts plus a "back-to-back" arrangement of ACME Beam Guard panels, a virtually impenetrable barrier is the result.

Rounded "BUFFER END" and smooth contour panels prevent catching or spearing of vehicles and they are re-directed back into their proper lane of traffic.

ACME Beam Guards form a rugged traffic separator that cannot be mounted.

- **Only 12" in width from face to face, traffic separators should be considered on anything less than a 20 ft. mall.**
- **No spearing or impaling of vehicles with the Exclusive ACME BUFFER END.**
- **Deep center panel corrugation and streamlined button head bolts eliminate the possibility of catching or hooking vehicles.**
- **Top and bottom of panel edges are purposely sloped away from traffic to minimize danger of a plate cutting edge.**

Logansport Metal Culvert Co.
Logansport, Indiana
Phone 5157

ACME Beam Guard

The Ultimate in Highway-

- SAFETY and PROTECTION
- DURABLE STRENGTH
- STREAMLINED BEAUTY
- LOW COST Erection & Maintenance

THIS SIDE OF CARD IS FOR ADDRESS

OUR PHONE NUMBER

5157

CALL US FOR YOUR DRAINAGE REQUIREMENTS

LOGANSPORT METAL CULVERT CO.

220 HANNA STREET **LOGANSPORT, INDIANA**

FORMED BOTTOM DRAINAGE STRUCTURES

	NORMAL DIAMETER	(Sq. Ft.)			(Sq. Ft.)	FORMED DIAMETER
16 Ga.	15″	1.227	END	AREA	1.1	18″x11″
16 Ga.	18″	1.767	″	″	1.5	22″ x 13″
16 Ga.	21″	2.4	″	″	2.2	25″ x 16″
14 Ga.	24″	3.142	″	″	2.8	29″ x 18″
14 Ga.	30″	4.909	″	″	4.4	36″ x 22″
12 Ga.	36″	7.068	″	″	6.4	43″ x 27″
12 Ga.	42″	9.621	″	″	8.7	50″ x 31″
12 Ga.	48″	12.566	″	″	11.4	58″ x 36″
12 Ga.	54″	16.000	″	″	14.3	65″ x 40″
10 Ga.	60″	19.635	″	″	17.6	72″ x 44″

LOGANSPORT METAL CULVERT CO.
LOGANSPORT, INDIANA

LOGANSPORT METAL CULVERT COMPANY — LOGANSPORT, INDIANA — TELEPHONE 5157

FULL CIRCLE DRAINAGE TABLE

This chart is based on Talbot's formula for determining correct culvert sizes for the area to be drained.

Diameter of Culvert in Inches	Area of Waterway Opening in Sq. Ft.	Acres of Mountainous Country	Acres of Rolling Country	Acres of Level Country
12	.785	¾	3	6
15	1.227	1	6	11
18	1.767	2	9	18
24	3.142	5	20	39
30	4.909	8	36	71
36	7.068	14	59	116
42	9.621	20	89	175
48	12.566	29	126	250
54	16.000	40	174	345
60	19.635	53	229	453
66	23.760	68	295	584
72	28.274	86	373	737
78	33.183	107	461	912
84	38.484	130	562	1111

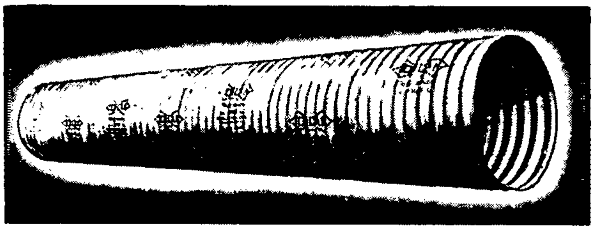
This table shows the number of smaller diameter culverts equal in water carrying capacity to that of one culvert of larger size. It is based on culverts laid on the same slope.

EXAMPLE—One 24″ diameter culvert is equivalent to five 12″ culverts or two 18″ culverts in water carrying capacity.

Dia. in Inches	12″	15″	18″	21″	24″	30″	36″	42″	48″	54″
12″	1									
15″	1.7	1								
18″	2.5	1.5	1							
21″	3.6	2.2	1.4	1						
24″	5	3	2	1.4	1					
30″	8	5	3	2.3	1.7	1				
36″	12	8	5	3.5	2.5	1.5	1			
42″	18	11	7	5	3.6	2.2	1.4	1		
48″	24	15	10	7	5	3	1.9	1.4	1	
54″	32	19	13	9	6.5	4	2.6	1.8	1.3	1
60″	41	25	16	11	8	5	3.3	2.3	1.7	1.3
66″	51	29	20	14	10	6	4	2.8	2	1.6
72″	63	37	25	17	12	7.5	5	3.5	2.5	1.9
84″	90	53	35	25	18	11	7	5	3.6	2.8

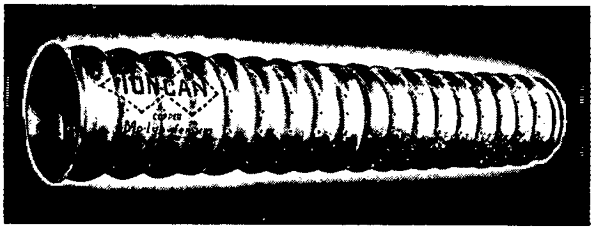
TONCAN DRAINAGE PRODUCTS

TONCAN IRON



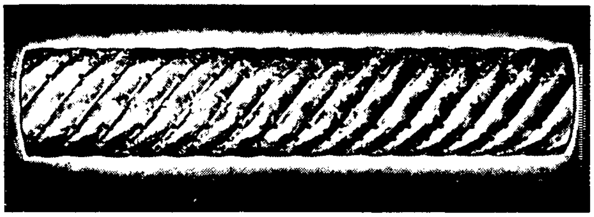
TONCAN IRON CORRUGATED METAL PIPE

A Standard Drainage Structure for 35 Years. Made of rust-resisting Toncan Copper Molybdenum Iron with 2 oz. zinc coating. • Fabrication complies with standard specifications. • Supplied in diameters from 6 to 84 inches, in any length, in multiples of 2 ft., and in 16 to 8 gauge depending on diameter of pipe. • Complete stock including fittings — connecting bands, tees, ells, crosses — available at various shipping points.



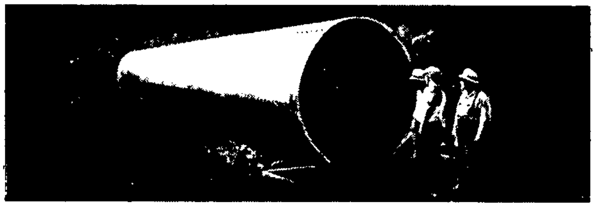
TONCAN IRON PERFORATED METAL PIPE

A Drainage Product Which is Quickly and Easily Installed and Assures Efficient Underdrainage with no Maintenance Cost. • Made of same base metal as corrugated pipe and is perforated before galvanizing. • Fabrication complies with standard specifications. • Supplied in diameters from 6 to 30 inches, in any length, in multiples of 2 ft. and in 16 or 14 gauge depending on diameter of pipe. • Complete stock including fittings available from various shipping points.



TONCAN IRON SUBDRAINAGE PIPE

A New Type of Pipe Designed for Stabilizing Soils Through Subdrainage. Made of same base metal as corrugated pipe. • Helically corrugated and perforated before galvanizing by hot dip process. • Supplied in 6 inch diameter. • Available in any length up to and including 24 ft., in 18 or 16 gauge. • Available in either perforated or non-perforated type. • Complete stock including fittings available from various shipping points or from Canton, Ohio.

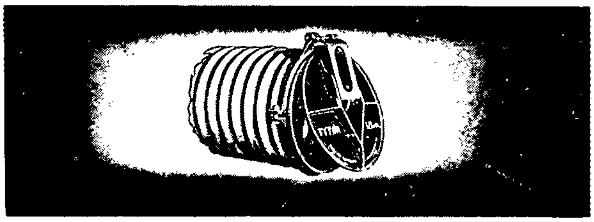


TONCAN IRON SECTIONAL PLATE PIPE

Suitable For Large Drainage Structures. • Same base metal as corrugated pipe. • Corrugations measure 6 inches from crest to crest, 2 inches in depth. Longitudinal seams in line and circumferential seams staggered when assembled. • Special bolts furnished. • Diameters of 6 inch intervals from 60 to 180 inches, in any length in multiples of 2 ft. • Gauges of 7, 5, 3, 1, or any combination. • Plain, skewed or sloped ends. • Erection plans furnished. • Shipment from Canton, Ohio.

TONCAN IRON SECTIONAL PLATE ARCHES

Provide for Durable and Attractive Small Bridges at Low Cost. • Made of same base metal as sectional plate pipe with same method of fabrication employed. • Available in wide range of spans and rises fabricated to meet field conditions. • Available in any length, in multiples of 2 ft., in 7, 5, 3 or 1 gauge or in any combination of these gauges. • Plain, skewed or sloped ends. • Complete erection plans furnished. • Delivery from Canton, Ohio.



TYTON AUTOMATIC GATES

A Scientifically Designed Gate which Permits Flow of Water in Only One Direction. • Designed to fit corrugated metal pipe or may be attached to concrete, stone or other types of headwalls. • Available in 8 to 36 inch diameters for shipment from stock and in larger diameters on order.

● Complete information and prices on any of the above products may be obtained from our Toncan representative.

LOGANSPORT METAL CULVERT CO.

LOGANSPORT, INDIANA

PHONE: 5157

TCM-490—5M 5-53 2815

PRINTED IN U. S. A.

Engineering Data

REPUBLIC SECTIONAL PLATE

PIPE
PIPE-ARCH
ARCHES

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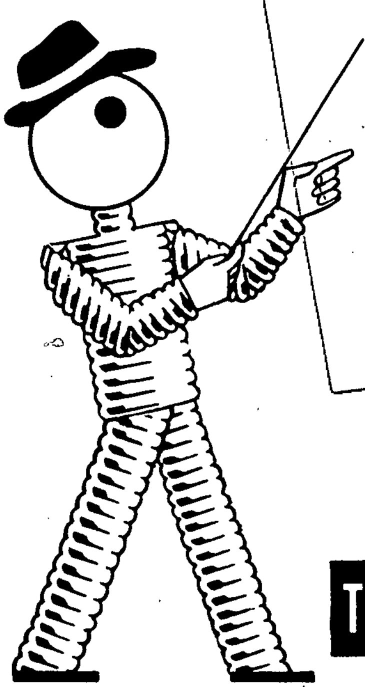


TONCAN

REPUBL C

Sectional Plate Drainage Products

Now made with new two-inch corrugations, Republic Sectional Plate Pipe, Pipe-Arch, and Arches are stronger than ever before. A greater range of sizes is offered; wider spans are possible in pipe-arch and arches; and pipe diameters are now offered in increments of even feet. Lengths of all sectional plate structure may be planned in multiples of two feet. These are big advantages in estimating and specifying drainage structures.

Once the diameter of the pipe, or the rise and span of the pipe-arch or arch, the length and correct gage to support the load, have been determined, it is necessary to write only a single specification for materials. No elaborate foundation tests need be conducted to calculate the strength of walls and other supporting members. And a single order covers all required materials — plates, bolts, nuts, washers, as well as angles and channels used in arch construction.

In addition, the well known economy features of corrugated sectional plate structures assume greater importance in these days of higher costs all around. Unskilled laborers erect Republic Sectional Plate structures because they are easier to transport, handle and assemble with simple tools. Excavation costs are less, since the structures can be assembled on the bank and rolled into place, or erected right in the stream bed. Costly headwalls, foundations, and shoring are seldom necessary.

Initial costs of Republic Sectional Plate are low. Records show that overall cost per year is amazingly small, with practically no maintenance required. The high rust-resistance of Toncan Iron, combined with the heavy protective three-ounce galvanized coating applied AFTER FABRICATION assure many, many years of trouble-free service.

SECTIONAL PLATE PIPE

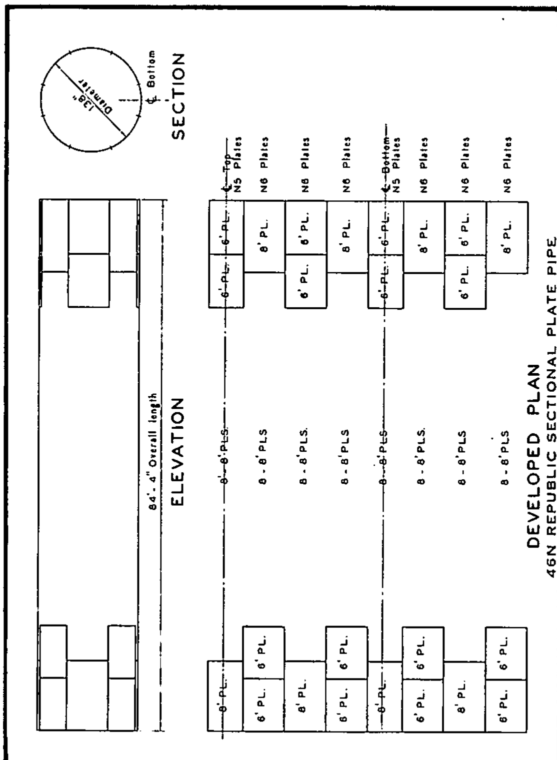
Dollar for dollar, full round sectional plate pipe usually provides the most economical drainage structure. Installation takes less time, cost of abutments and piers is eliminated, and less equipment is required. Pipe with sloped or skewed ends with carefully laid rip-rap presents a pleasing appearance. Pipe is preferable when there is doubt as to the bearing value of the foundation, but in cases where extremely soft and unstable conditions make it necessary, timber or gravel mats should be used.

Full-round sectional pipe is now available in diameters from five to 15 feet in increments of six inches. Lengths from six feet minimum in increments of two feet. See tables and drawings on Pages 1, 3, 4, and 5.

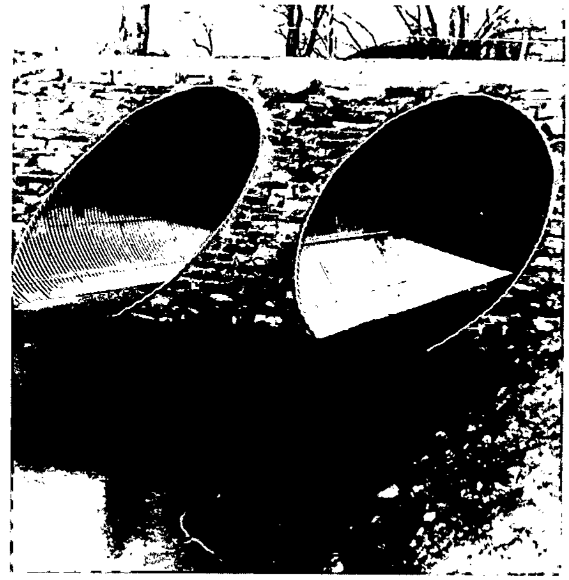
Four men can usually carry the heaviest plate if straw hooks are used to facilitate handling.

Copyright 1949, Republic Steel Corporation

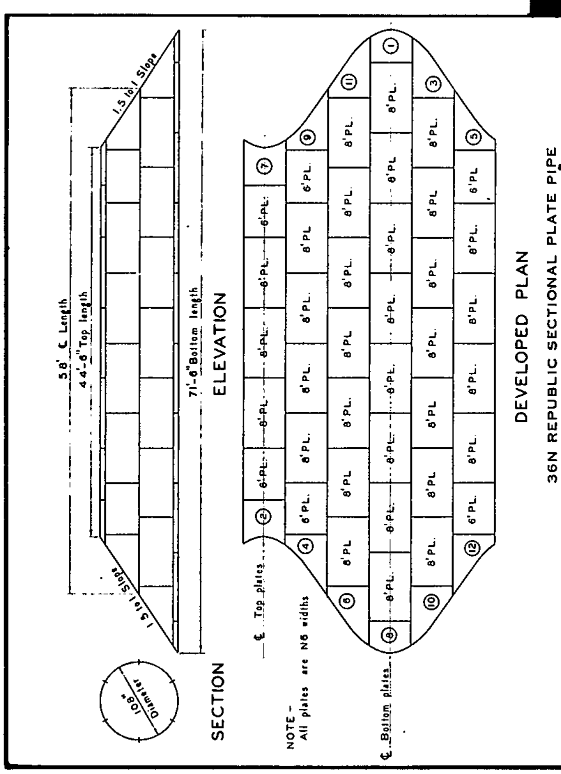
SECTIONAL PLATE PIPE



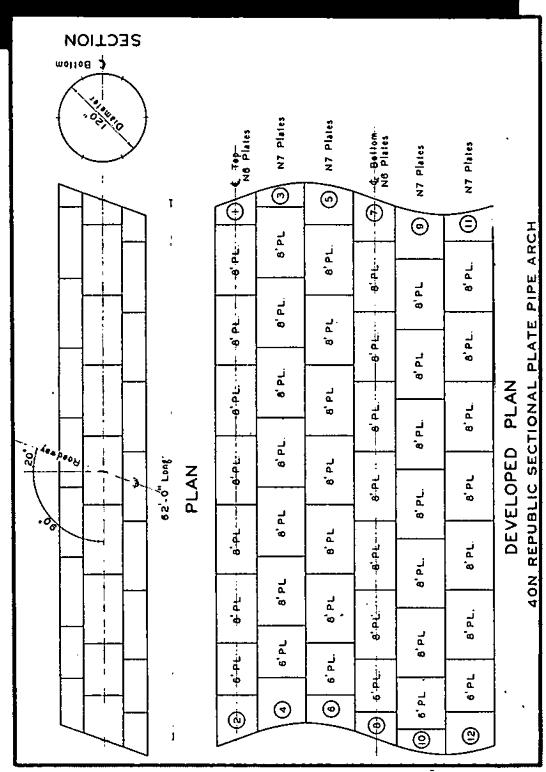
Typical Plate Assembly Plan for Republic Sectional Plate Pipe with Plain Ends



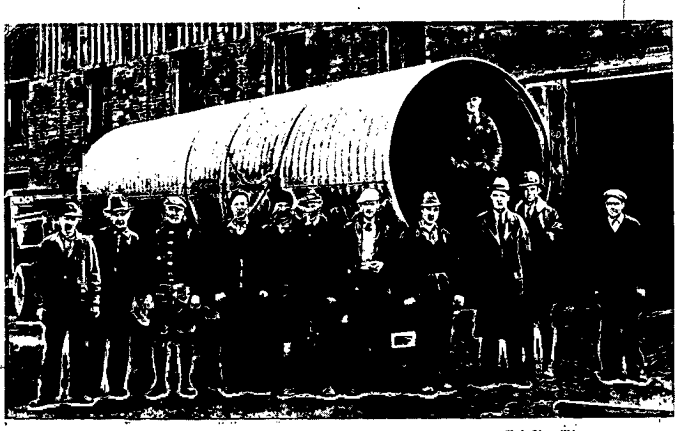
When Sectional Plate Pipe has ends sloped to conform to fill, and stone rip-rap is used, a neat job results at low cost.



Typical Plate Assembly Plan for Republic Sectional Plate Pipe with Sloped Ends



Typical Plate Assembly Plan for Republic Sectional Plate Pipe with Skewed Ends



Sectional Plate Pipe and Pipe-Arch are almost 100% salvageable. This one will be used at a new location, effecting a considerable saving of money.

SECTIONAL PLATE PIPE-ARCH

Offering all of the advantages of full-round pipe, Republic Sectional Plate Pipe-Arch has proved its efficiency for locations where headroom is limited, and is the perfect answer to the problem of handling a large volume of water with rapid run-off, to avoid ponding. Pipe-Arch is installed in the same manner as full round sectional plate pipe. It requires no expensive foundation, and the preparation of the site is easy. Excavation is simpler and less costly, and it is usually unnecessary to divert stream.

As with other Republic Sectional Plate drainage structures, Pipe-Arch is assembled with nuts, bolts, and washers that have been especially designed for the purpose. The combination bolt head and washer fits the valley of the corrugation, providing full bearing, and making tightening of the nut easy. Separate washers to fit the crest of the corrugation provide a full bearing surface for the nut, and prevent abrasion of the galvanizing.

Pipe-Arch is now available in spans from approximately six to 17 feet, with rises from 4 ft. 7 inches to 10 ft. one inch. Lengths from minimum six feet in increments of two feet. See tables and drawings on Pages 5, 6, and 7.

SECTIONAL PLATE ARCHES

Arch structures are usually specified when there is insufficient head room clearance to install full-round pipe of adequate drainage area, where appearance is a major consideration, or where maximum opening is needed near the flow line. Arches are widely used to replace obsolete structures, and may be adapted to bridges of fairly large size over wide streams by using two or more arch openings (see picture on Page 8).

Arches are now available in spans from five to 28 feet in increments of even feet, with rises from 1 ft. 8½ inches to 14 ft. 5½ inches. Each span has a range of rises available to meet varied field conditions. Lengths from minimum six feet in increments of two feet. See tables and drawings on Pages 8, 9, 10, 11, and 12.

TONCAN IRON

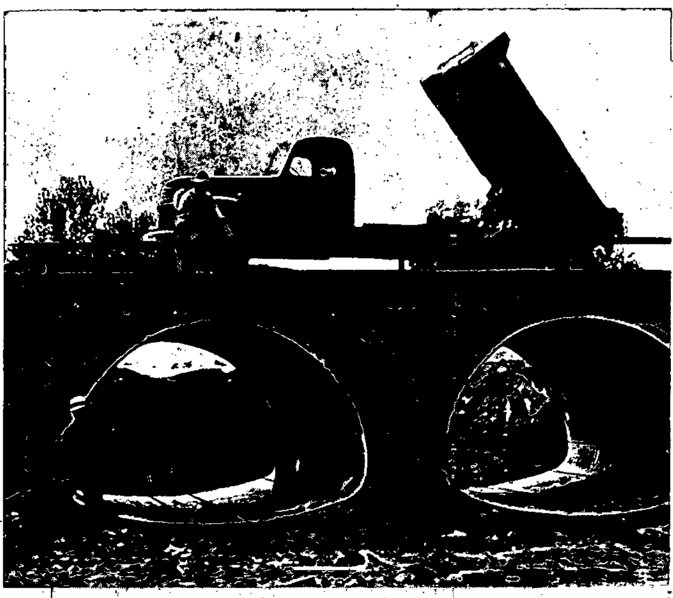
Toncan Iron is the result of continuous and progressive improvement. It is an alloy iron with the highest rust-resistance of any ferrous metal in its price class.

To highly refined open hearth iron with its established ability to combat corrosion, Republic Steel metallurgists first added copper, producing a marked increase in rust-resistance. The search for improvement did not stop, however. Research showed that the addition of molybdenum to the iron-copper alloy had two effects. First, and very important, it doubled the amount of copper that could be successfully added.

Second, it refined the grain structure of the metal and increased the effectiveness of the copper. This addition also increased ductility and toughness.

Today, Toncan Iron contains a minimum of 0.40% copper, twice the amount used in copper-bearing irons and steels, plus 0.05% molybdenum.

Pipe-Arch used to build small bridge replacing old dilapidated wooden structure. Forms have just been removed from concrete headwalls. Stone found on the site is often used.



Strutting Sectional Plate Pipe

When Sectional Plate Pipe is to be strutted three percent out of round, the following procedure should be followed:

All timbers used are to be sound, of the sizes, and so spaced, as indicated in the table at top of Page 4. The struts and top and bottom sills are to be of hard wood. Compression caps should be soft wood, preferably straight grained fir, as they must give as the fill is made.

Two 50-ton jacks are adequate, although a third may be used. These rest on timber bearing blocks on each side of the bottom sill. Heavy metal plates should be used between tops of the jacks and the jacking timbers, also between timbers and top sill. See sketch. Top and bottom sills shall have joints staggered a minimum distance of three feet, and each section shall be continuous across at least two struts.

STANDARD SIZES

REPUBLIC SECTIONAL PLATE PIPE

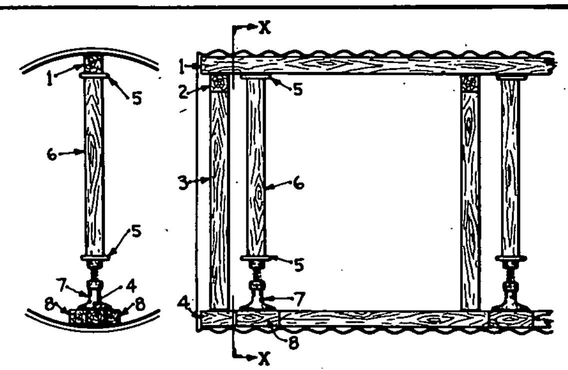
Nominal Diameter, Area and N Number

NOMINAL DIAMETER		WATERWAY AREA	N
(Ft.—In.)	(In.)		
5'-0"	60"	20	20
5'-6"	66"	24	22
6'-0"	72"	28	24
6'-6"	78"	33	26
7'-0"	84"	38	28
7'-6"	90"	44	30
8'-0"	96"	50	32
8'-6"	102"	57	34
9'-0"	108"	64	36
9'-6"	114"	71	38
10'-0"	120"	79	40
10'-6"	126"	87	42
11'-0"	132"	95	44
11'-6"	138"	104	46
12'-0"	144"	113	48
12'-6"	150"	123	50
13'-0"	156"	133	52
13'-6"	162"	143	54
14'-0"	168"	154	56
14'-6"	174"	165	58
15'-0"	180"	177	60

To begin strutting, place one jack directly behind the proposed location of first strut, and the other behind that of second strut. Apply pressure uniformly until vertical axis of pipe has been elongated enough to place first strut and compression cap. Pressure is then released on jack and it is moved to location of third strut. Second strut is then placed and jack moved to location of fourth strut. Process is repeated until entire pipe is completed.

Jacks should be placed so operators can watch each other. Care must be used in plumbing jacks and timbers before applying pressure, and during work any tendency to get out of plumb must be checked by using knee brace, or re-setting jack and timber, the latter being advisable.

Strutting shall be carried uniformly from end to end of pipe, except that pipes having sloped ends or headwalls require no elongation at those locations. Struts should usually be left in place until fill is compacted. If any unusual distortions are noticed due to severe concentrated loads, or should the pipe show any tendency to "roof" over the upper sill, the struts should be removed at once.



SECTION-XX SECTION THROUGH CENTER OF PIPE

1 - Top sill
2 - Compression cap
3 - Strut
4 - Bottom sill
5 - Metal plates
6 - Jacking timber
7 - Jack (50 ton)
8 - Bearing blocks

LENGTH AND SPACING OF STRUTS FOR SECTIONAL PLATE PIPE

HEIGHT OF COVER IN FEET	LEAST END DIMENSION OF SILL*, CAP* AND STRUT*	DIAMETER OF PIPE IN INCHES																				
		60		72		84		96		108		120		132		144		156		168		180	
		LENGTH OF STRUTS IN INCHES**																					
	4 INCH	49¾		62⅛		74½		86⅞		99¼		111½		124		136¼		148¾		161			
	6 INCH	43¾		56⅛		68½		80⅞		93¼		105½		118		130¼		142¾		155		167½	
	8 INCH			50⅛		62½		74⅞		87¼		99½		112		124¼		136¾		149		161½	
		Size in Inches	Spacing in Feet	Size in Inches	Spacing in Feet	Size in Inches	Spacing in Feet	Size in Inches	Spacing in Feet	Size in Inches	Spacing in Feet	Size in Inches	Spacing in Feet	Size in Inches	Spacing in Feet	Size in Inches	Spacing in Feet	Size in Inches	Spacing in Feet	Size in Inches	Spacing in Feet	Size in Inches	Spacing in Feet
5		4x4	6.0	4x4	6.0	4x4	6.0	4x4	6.0	4x4	6.0	4x4	6.0	4x4	4.5	4x4 4x6	3.5 6.0	4x4 4x6	3.0 5.0	4x6 6x6	4.5 6.0	4x6 6x6	4.0 6.0
10		4x4	6.0	4x4	6.0	4x4	6.0	4x4	6.0	4x4 4x6	4.5 6.0	4x4 4x6	4.0 5.5	4x4 4x6	3.5 5.0	4x6 6x6	4.5 6.0	4x6 6x6	4.0 6.0	4x6 6x6	3.5 5.5	6x6 6x8	5.0 6.0
15		4x4	6.0	4x4	6.0	4x4	5.5	4x4 4x6	4.5 6.0	4x4 4x6	3.5 5.5	4x6 6x6	4.5 6.0	4x6 6x6	4.0 6.0	4x6 6x6	3.5 5.5	4x6 6x6	3.0 5.0	6x6 6x8	4.5 6.0	6x6 6x8	4.0 5.5
20		4x4	6.0	4x4 4x6	5.5 6.0	4x4 4x6	4.5 6.0	4x4 4x6	3.5 5.5	4x6 6x6	4.5 6.0	4x6 6x6	4.0 5.5	4x6 6x6	3.5 5.0	6x6 6x8	4.5 6.0	6x6 6x8	4.0 5.5	6x6 6x8	3.5 5.0	6x8 8x8	4.5 6.0
30		4x4 4x6	4.5 6.0	4x4 4x6	3.5 5.5	4x4 4x6	3.0 4.5	4x6 6x6	4.0 6.0	4x6 6x6	3.0 5.0	6x6 6x8	4.5 6.0	6x6 6x8	4.0 5.5	6x6 6x8	3.5 5.0	6x8 8x8	4.5 6.0	6x8 8x8	4.0 5.0	6x8 8x8	3.5 5.0
40		4x4 4x6	3.5 5.0	4x6 6x6	4.0 6.0	4x6 6x6	3.5 5.0	6x6 6x8	4.5 6.0	6x6 6x8	4.0 5.5	6x6 6x8	3.5 4.5	6x6 6x8	3.0 4.0	6x8 8x8	4.0 5.0	6x8 8x8	3.5 4.5	6x8 8x8	3.0 4.5	6x8 8x8	3.0 4.0
50		4x4 4x6	3.0 4.0	4x6 6x6	3.5 5.0	6x6 6x8	4.0 5.5	6x6 6x8	3.5 5.0	6x6 6x8	3.0 4.5	6x8 8x8	4.0 5.5	6x8 8x8	3.5 4.5	6x8 8x8	3.0 4.5	8x8	4.0	8x8	3.5	8x8	3.0
60		4x6 6x6	3.5 5.5	6x6 6x8	4.0 5.5	6x6 6x8	3.5 4.5	6x8 8x8	4.5 5.5	6x8 8x8	4.0 5.0	6x8 8x8	3.0 4.5	6x8 8x8	3.0 4.0	8x8	3.5	8x8	3.5	8x8	3.0		
70		6x6 6x8	4.5 6.0	6x6 6x8	3.5 5.0	6x8 8x8	4.0 5.5	6x8 8x8	3.5 5.0	6x8 8x8	3.0 4.5	8x8	4.0	8x8	3.5	8x8	3.0	8x8	3.0				
80		6x6 6x8	4.0 5.0	6x8 8x8	4.0 5.5	6x8 8x8	3.5 5.0	6x8 8x8	3.0 4.5	8x8	4.0	8x8	3.5	8x8	3.0								
100		6x6 6x8	3.0 4.0	6x8 8x8	3.5 4.5	8x8	4.0	8x8	3.5	8x8	3.0												

* Transverse Cap & Sill should be placed with least dimension vertical.

** Length of Struts based on 3% elongation or L = D + 3% — 3 times the least dimension of the strutting material.

All timber dimensions are assumed as exact rather than nominal.

MINIMUM GAGES FOR TOP AND SIDE PLATES*

REPUBLIC SECTIONAL PLATE PIPE

FIELD STRUTTED PIPE H-20 LIVE LOAD

DIAM. INCHES	HEIGHT OF COVER IN FEET														
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-70	71-80	81-100
60	12	12	12	12	12	12	12	12	12	12	12	10	10	8	7
66	12	12	12	12	12	12	12	12	12	12	10	10	10	8	7
72	12	12	12	12	12	12	12	12	12	10	10	10	8	7	5
78	12	12	12	12	12	12	12	12	10	10	10	10	8	7	3
84	12	12	12	12	12	12	12	10	10	10	10	8	8	5	3
90	12	12	12	12	12	12	10	10	10	10	8	8	7	3	1
96	12	12	12	12	12	10	10	10	10	10	8	7	7	3	1
102	12	12	12	10	10	10	10	10	10	8	7	7	5	3	
108	12	12	12	10	10	10	10	10	8	8	7	7	5	1	
114	12	12	12	10	10	10	10	8	8	7	7	5	3	1	
120	12	12	12	10	10	10	8	8	7	7	5	3	3		
126	10	12	10	10	10	8	8	8	7	5	3	3	1		
132	10	10	10	10	8	8	8	7	7	5	3	3	1		
138	10	10	10	10	8	8	8	7	5	5	3	1			
144	10	10	10	10	8	8	7	7	5	3	1	1			
150	10	10	10	8	8	7	7	5	3	3	1				
156	10	10	10	8	8	7	7	5	3	1					
162	8	10	8	8	8	7	7	5	3	1					
168	8	10	8	8	7	7	7	3	1						
174	8	8	8	8	7	7	7	3	1						
180	8	8	8	8	7	7	5	3							

NOTE: This table based on four ¾" diameter SAE 1040 H. T. steel bolts per foot of longitudinal seam.

* Bottom plates of heavier gage may be used to resist greater wear.

MINIMUM GAGES FOR TOP AND SIDE PLATES*

REPUBLIC SECTIONAL PLATE PIPE

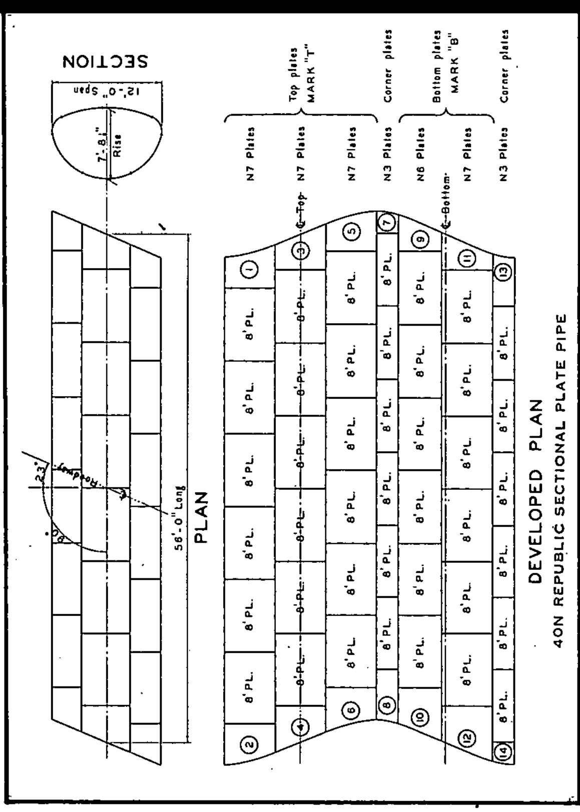
UNSTRUTTED PIPE H-20 LIVE LOAD

DIAM. INCHES	HEIGHT OF COVER IN FEET														
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-70	71-80	81-100
60	12	12	12	12	12	12	12	10	10	10	8	8	8	7	7
66	12	12	12	12	12	12	10	10	10	8	8	8	7	7	5
72	12	12	12	12	12	10	10	10	8	8	8	7	7	5	3
78	12	12	12	10	10	10	8	8	7	7	7	7	7	5	1
84	12	12	12	10	10	8	8	8	7	7	7	7	5	3	
90	12	12	10	10	8	8	7	7	7	7	5	5	5	3	
96	10	12	10	8	8	7	7	7	5	5	5	5	3	1	
102	10	12	10	8	8	7	7	7	5	5	5	5	3		
108	10	10	10	8	7	7	7	5	5	5	3	3	1		
114	10	10	10	8	7	7	5	5	5	3	3	3			
120	10	10	8	7	7	5	5	5	3	3	1	1			
126	10	10	8	7	7	5	5	3	3	1	1				
132	8	10	8	7	7	5	5	3	3	1					
138	8	8	7	7	5	5	3	3	1	1					
144	7	8	7	5	5	5	3	3	1						
150	7	8	7	5	5	3	3	1							
156	7	8	7	5	5	3	1								
162	7	7	7	5	3	1	1								
168	5	7	5	5	3										
174	5	7	5	3	1										
180	5	5	5	3											

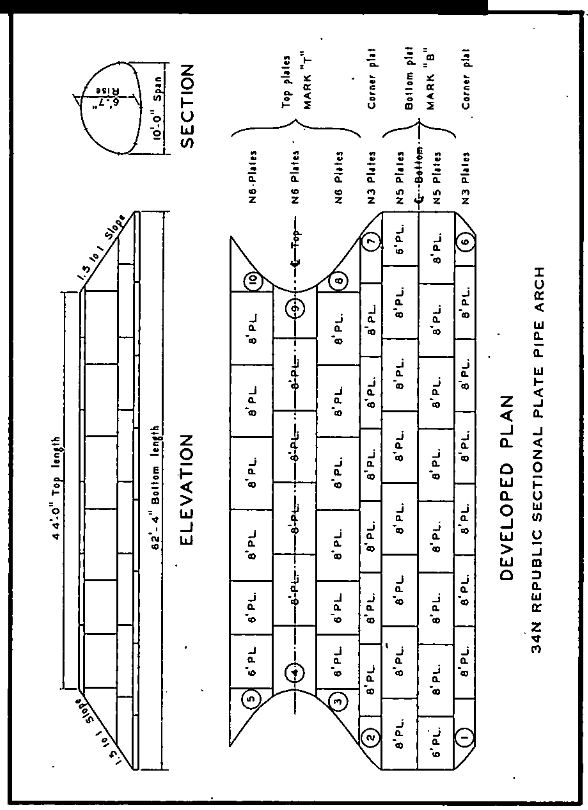
NOTE: This table based on four ¾" diameter SAE 1040 H. T. steel bolts per foot of longitudinal seam.

* Bottom plates of heavier gage may be used to resist greater wear.

SECTIONAL PLATE PIPE-ARCH



Typical Plate Assembly Plan for Republic Sectional Plate Pipe-Arch with Skewed Ends



Typical Plate Assembly Plan for Republic Sectional Plate Pipe-Arch with Sloped Ends

REPUBLIC SECTIONAL PLATE

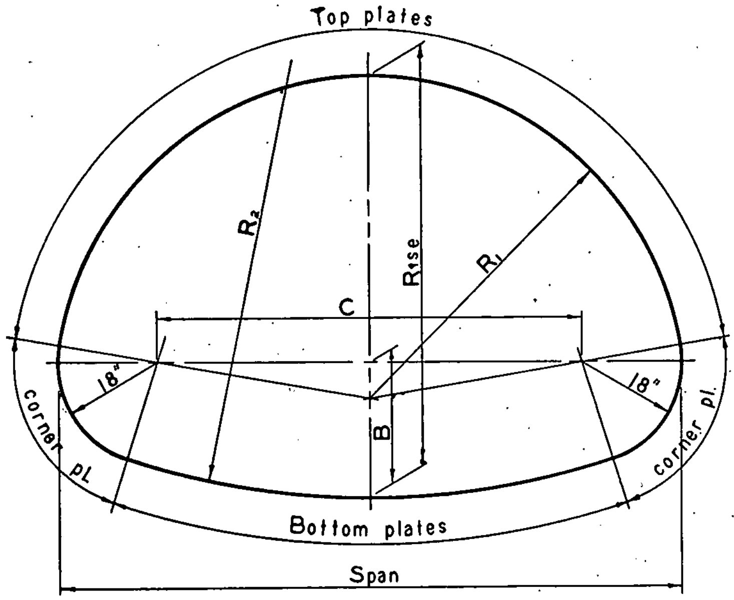
PIPE - ARCH

TABLE OF MINIMUM GAGES

FOR

H-15 AND H-20 LIVE LOAD

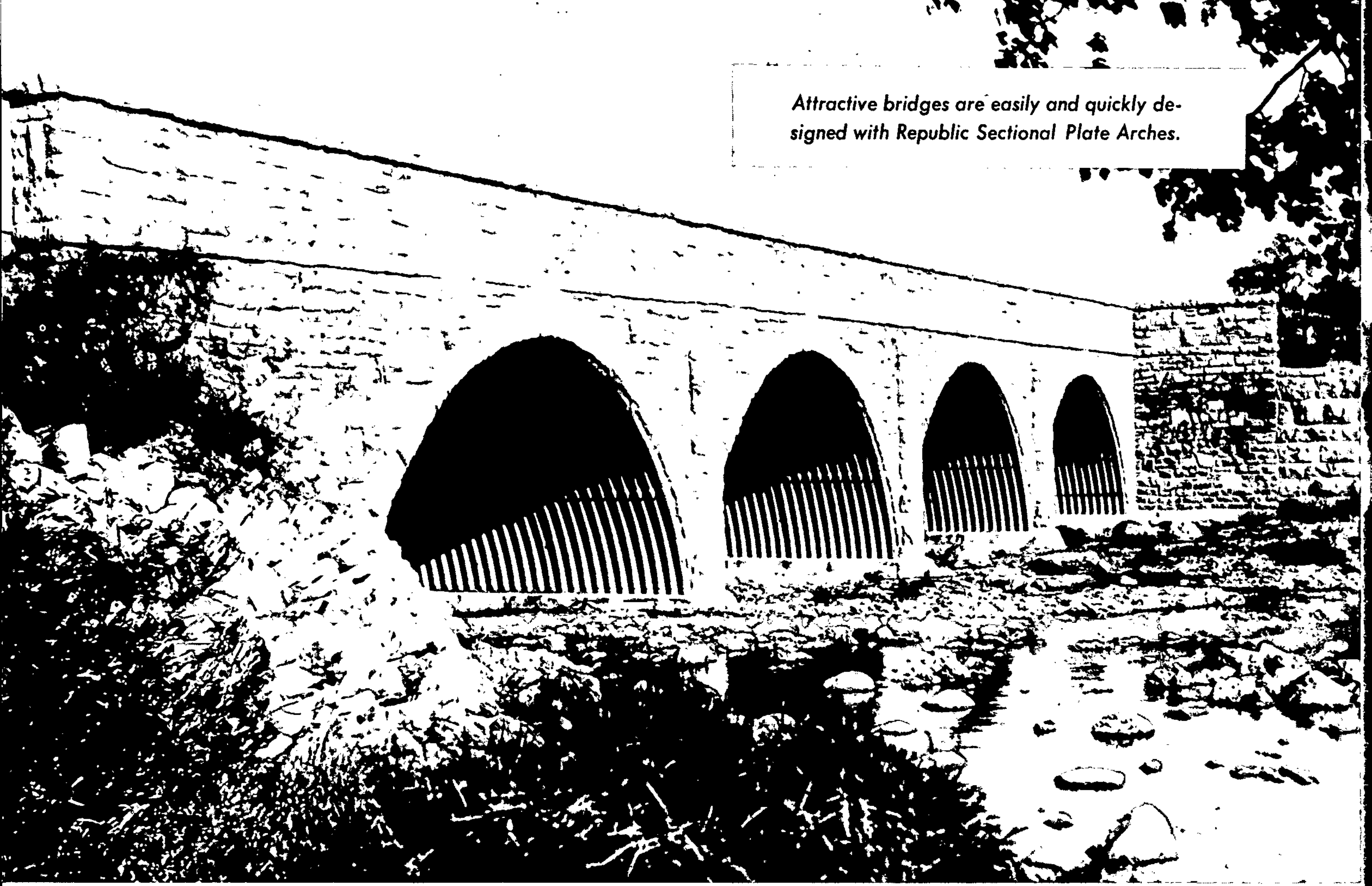
Span	Rise	Area	H-15 LIVE LOAD															H-20 LIVE LOAD														
			Height of Cover in Feet															Height of Cover in Feet														
		Sq. Ft.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6'- 1"	4'- 7"	22	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
6'- 4"	4'- 9"	24	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10
6'- 9"	4'-11"	26	10	12	12	12	12	12	12	12	12	12	12	12	12	10	10	10	12	12	12	12	12	12	12	12	12	12	12	12	10	10
7'- 0"	5'- 1"	28	10	12	12	12	12	12	12	12	12	12	12	12	12	10	10	10	12	12	12	12	12	12	12	12	12	12	12	12	10	10
7'- 3"	5'- 3"	31	10	12	12	12	12	12	12	12	12	12	12	12	10	10	10	10	10	12	12	12	12	12	12	12	12	12	12	10	10	10
7'- 8"	5'- 5"	33	10	10	12	12	12	12	12	12	12	12	12	10	10	10	10	10	10	10	12	12	12	12	12	12	12	12	10	10	10	10
7'-11"	5'- 7"	35	10	10	12	12	12	12	12	12	12	12	12	10	10	10	10	10	10	10	12	12	12	12	12	12	12	12	10	10	10	10
8'- 2"	5'- 9"	38	10	10	10	12	12	12	12	12	12	12	10	10	10	10	10	10	10	10	10	12	12	12	12	12	12	10	10	10	10	10
8'- 7"	5'-11"	40	10	10	10	10	12	12	12	12	12	10	10	10	10	10	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	8
8'-10"	6'- 1"	43	10	10	10	10	12	12	12	10	10	10	10	10	10	8	8	10	10	10	10	10	10	10	10	10	10	10	10	10	8	8
9'- 4"	6'- 3"	46	8	10	10	10	10	10	10	10	10	10	10	10	8	8	8	8	10	10	10	10	10	10	10	10	10	10	10	8	8	8
9'- 6"	6'- 5"	49	8	10	10	10	10	10	10	10	10	10	10	8	8	8	7	8	8	10	10	10	10	10	10	10	10	10	8	8	8	7
9'- 9"	6'- 7"	52	8	10	10	10	10	10	10	10	10	10	10	8	8	8	7	8	8	10	10	10	10	10	10	10	10	10	8	8	8	7
10'- 3"	6'- 9"	55	8	10	10	10	10	10	10	10	10	10	8	8	8	7	7	8	8	10	10	10	10	10	10	10	10	8	8	8	7	7
10'- 8"	6'-11"	58	8	8	10	10	10	10	10	10	10	10	8	8	8	7	7	8	8	8	10	10	10	10	10	10	10	8	8	8	7	7
10'-11"	7'- 1"	61	8	8	10	10	10	10	10	10	10	8	8	8	7	7	5	8	8	8	10	10	10	10	10	10	8	8	8	7	7	5
11'- 5"	7'- 3"	64	8	8	10	10	10	10	10	10	8	8	8	8	7	5	5	7	8	8	8	10	10	10	10	8	8	8	8	7	5	5
11'- 7"	7'- 5"	67	8	8	10	10	10	10	10	8	8	8	8	7	5	5	5	7	8	8	8	8	10	10	8	8	8	8	7	5	5	5
11'-10"	7'- 7"	71	8	8	10	10	10	10	10	8	8	8	8	7	5	5	3	7	8	8	8	8	8	8	8	8	8	8	7	5	5	3
12'- 4"	7'- 9"	74	8	8	8	10	10	10	10	8	8	8	8	7	5	5	3	7	7	8	8	8	8	8	8	8	8	7	7	5	5	3
12'- 6"	7'-11"	78	7	8	8	10	10	10	8	8	8	8	8	7	5	5	3	7	7	8	8	8	8	8	8	8	8	7	7	5	5	3
12'- 8"	8'- 1"	81	7	8	8	8	10	10	8	8	8	8	8	7	5	5	3	5	7	8	8	8	8	8	8	8	8	7	7	5	5	3
12'-10"	8'- 4"	85	7	8	8	8	10	10	8	8	8	7	7	5	5	3	1	5	7	8	8	8	8	8	8	8	7	7	5	5	3	1
13'- 5"	8'- 5"	89	7	7	8	8	8	8	8	8	7	7	5	5	3	3	1	5	5	7	7	8	8	8	8	7	7	5	5	3	3	1
13'-11"	8'- 7"	93	5	7	8	8	8	8	8	7	7	5	5	3	3	1	1	5	5	7	7	8	8	8	7	7	5	5	3	3	1	1
14'- 1"	8'- 9"	97	5	7	8	8	8	8	8	7	7	5	5	3	3	1	1	5	5	7	7	8	8	8	7	7	5	5	3	3	1	1
14'- 3"	8'-11"	101	5	7	7	8	8	8	8	7	7	5	5	3	3	1	1	3	5	5	7	7	7	7	7	7	5	5	3	3	1	1
14'-10"	9'- 1"	105	5	5	7	7	8	8	7	7	5	3	3	1	1	—	—	3	5	5	7	7	7	7	7	5	3	3	1	1	—	—
15'- 4"	9'- 3"	109	5	5	5	7	7	7	7	7	5	3	3	1	—	—	—	3	5	5	7	7	7	7	7	5	3	3	1	—	—	—
15'- 6"	9'- 5"	113	3	5	5	7	7	7	7	5	3	3	1	1	—	—	—	1	3	5	5	7	7	7	5	3	3	1	1	—	—	—
15'- 8"	9'- 7"	118	3	5	5	7	7	7	7	5	3	3	1	1	—	—	—	1	3	5	5	7	7	7	5	3	3	1	1	—	—	—
15'-10"	9'-10"	122	3	5	5	7	7	7	7	5	3	3	1	1	—	—	—	1	3	5	5	7	7	7	5	3	3	1	1	—	—	—
16'- 5"	9'-11"	126	1	3	5	5	5	5	5	3	3	1	1	—	—	—	—	—	1	3	3	5	5	5	3	3	1	1	—	—	—	—
16'- 7"	10'- 1"	131	1	3	3	5	5	5	5	3	3	1	1	—	—	—	—	—	1	3	3	5	5	5	3	1	1	1	—	—	—	—



SIZES AND LAYOUT DETAILS
REPUBLIC SECTIONAL PLATE PIPE - ARCH

Span	Rise	Area Sq. Ft.	REQUIRED N			B	C	INSIDE PLATE RADIUS**	
			Top	Bottom	Total*			R_1	R_2
6′- 1″	4′- 7″	22	11	5	22	21.0″	37.1″	36.7″	76.4″
6′- 4″	4′- 9″	24	12	5	23	20.5″	40.1″	38.1″	98.9″
6′- 9″	4′-11″	26	12	6	24	22.0″	45.3″	41.0″	83.5″
7′- 0″	5′- 1″	28	13	6	25	21.4″	48.2″	42.3″	104.5″
7′- 3″	5′- 3″	31	14	6	26	20.8″	51.0″	43.5″	136.5″
7′- 8″	5′- 5″	33	14	7	27	22.4″	56.4″	46.5″	109.9″
7′-11″	5′- 7″	35	15	7	28	21.7″	59.2″	47.7″	138.4″
8′- 2″	5′- 9″	38	16	7	29	20.9″	61.7″	48.9″	183.1″
8′- 7″	5′-11″	40	16	8	30	22.7″	67.4″	51.9″	141.3″
8′-10″	6′- 1″	43	17	8	31	21.8″	70.0″	53.0″	179.2″
9′- 4″	6′- 3″	46	17	9	32	23.8″	75.7″	56.2″	144.9″
9′- 6″	6′- 5″	49	18	9	33	22.9″	78.3″	57.2″	178.2″
9′- 9″	6′- 7″	52	19	9	34	21.9″	80.6″	58.3″	228.0″
10′- 3″	6′- 9″	55	19	10	35	23.9″	86.6″	61.5″	178.9″
10′- 8″	6′-11″	58	19	11	36	26.2″	92.5″	64.9″	153.2″
10′-11″	7′- 1″	61	20	11	37	25.1″	95.0″	65.8″	180.8″
11′- 5″	7′- 3″	64	20	12	38	27.4″	100.9″	69.4″	157.8″
11′- 7″	7′- 5″	67	21	12	39	26.3″	103.4″	70.2″	183.4″
11′-10″	7′- 7″	71	22	12	40	25.2″	105.7″	71.1″	217.0″
12′- 4″	7′- 9″	74	22	13	41	27.5″	111.8″	74.7″	186.5″
12′- 6″	7′-11″	78	23	13	42	26.3″	114.2″	75.5″	217.4″
12′- 8″	8′- 1″	81	24	13	43	25.2″	116.4″	76.3″	258.4″
12′-10″	8′- 4″	85	25	13	44	24.0″	118.4″	77.2″	315.2″
13′- 5″	8′- 5″	89	25	14	45	26.3″	124.9″	80.7″	255.7″
13′-11″	8′- 7″	93	25	15	46	28.9″	131.1″	84.4″	220.8″
14′- 1″	8′- 9″	97	26	15	47	27.6″	133.3″	85.1″	254.8″
14′- 3″	8′-11″	101	27	15	48	26.3″	135.4″	85.9″	298.7″
14′-10″	9′- 1″	105	27	16	49	28.9″	141.9″	89.5″	254.9″
15′- 4″	9′- 3″	109	27	17	50	31.6″	148.1″	93.4″	226.5″
15′- 6″	9′- 5″	113	28	17	51	30.2″	150.4″	94.0″	255.9″
15′- 8″	9′- 7″	118	29	17	52	28.8″	152.5″	94.7″	292.5″
15′-10″	9′-10″	122	30	17	53	27.4″	154.5″	95.4″	339.1″
16′- 5″	9′-11″	126	30	18	54	30.1″	161.0″	99.2″	291.6″
16′- 7″	10′- 1″	131	31	18	55	28.7″	163.1″	99.8″	333.8″

*Includes 6N for two N3 corner plates.
**All corner plates are curved to 18″ inside radius.
All dimensions are measured from inside crests. Tolerances must be allowed for specification purposes.



Attractive bridges are easily and quickly designed with Republic Sectional Plate Arches.

SECTIONAL PLATE ARCHES

STANDARD SIZES

Span (Ft.)	Rise (Ft. & In.)	Opening (Sq. Ft.)	N	R/S	Radius (Inches)
5′	2′- 7¼″	10	10	H.C.	30″
5′	2′- 2¾″	8	9	0.445	30¼″
6′	3′- 1½″	15	12	H.C.	36″
6′	2′- 3¾″	10	10	0.385	37¼″
6′	1′-10″	8	9	0.305	40½″
7′	3′- 7¾″	20	14	H.C.	42″
7′	2′-10″	15	12	0.405	43″
7′	1′-10″	9	10	0.262	51″
8′	4′- 2″	26	16	H.C.	48″
8′	3′- 9¼″	23	15	0.471	48″
8′	3′ -4¼″	20	14	0.419	48¾″
8′	2′- 4¾″	14	12	0.299	54½″
9′	4′- 8″	33	18	H.C.	54″
9′	4′- 3¼″	30	17	0.476	54″
9′	3′-10¼″	26	16	0.430	54¾″
9′	3′- 5″	23	15	0.381	56¼″
9′	2′-11¼″	19	14	0.327	59″
9′	1′- 8½″	11	12	0.191	81″

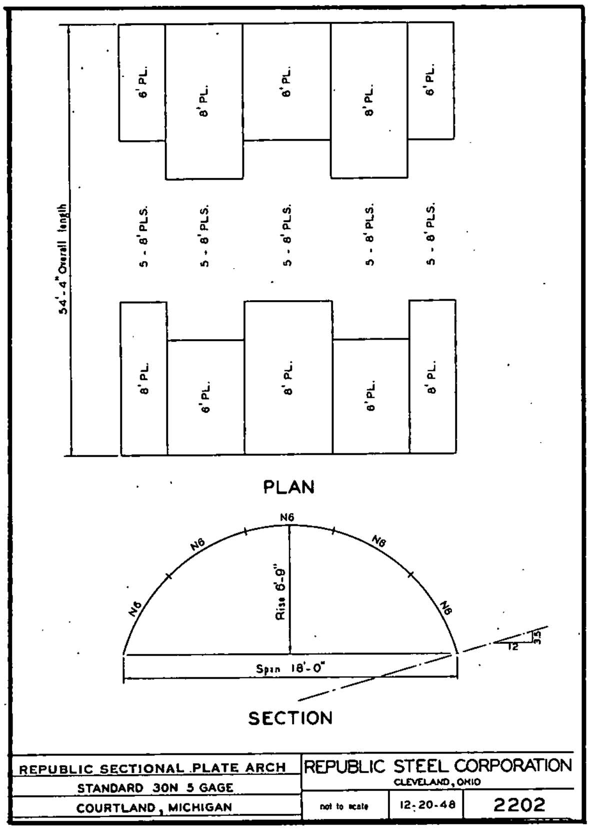
Span (Ft.)	Rise (Ft. & In.)	Opening (Sq. Ft.)	N	R/S	Radius (Inches)
10′	5′- 2¼″	41	20	H.C.	60″
10′	4′- 9½″	37	19	0.480	60″
10′	4′- 4½″	33	18	0.439	60½″
10′	3′-11¼″	29	17	0.395	61¾″
10′	3′- 5¾″	25	16	0.348	64″
10′	2′-11½″	21	15	0.296	68½″
10′	2′- 4¼″	16	14	0.238	77½″
11′	5′- 8½″	50	22	H.C.	66″
11′	5′- 3¾″	45	21	0.483	66″
11′	4′-10¾″	41	20	0.445	66½″
11′	4′- 5½″	37	19	0.406	67½″
11′	4′- 0″	32	18	0.364	69½″
11′	3′- 6″	28	17	0.319	73″
11′	2′-11½″	23	16	0.269	79¼″
12′	6′- 2½″	59	24	H.C.	72″
12′	5′- 5″	50	22	0.451	72½″
12′	4′- 6½″	40	20	0.378	75″
12′	4′- 0½″	35	19	0.330	77¾″
12′	3′- 6¼″	30	18	0.294	82½″
13′	6′- 8¾″	69	26	H.C.	78″
13′	5′-11″	59	24	0.456	78½″

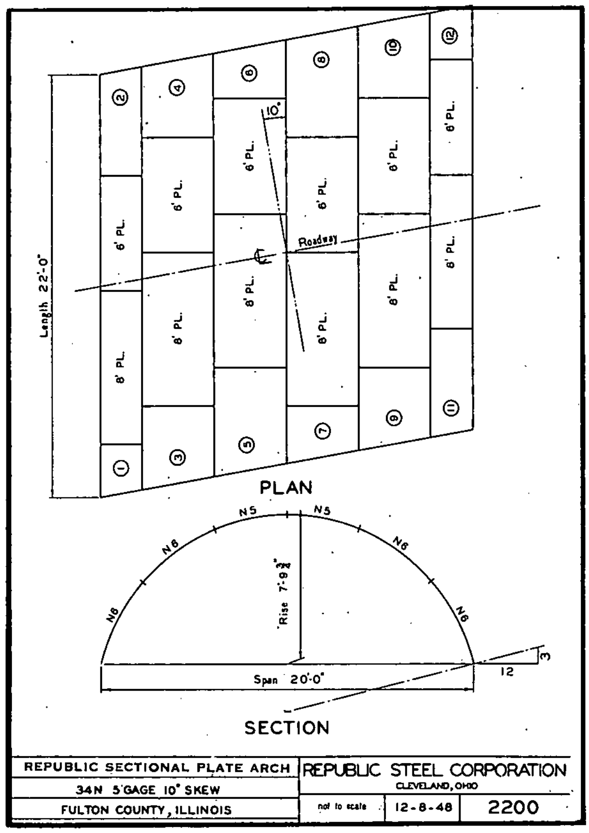
STANDARD SIZES

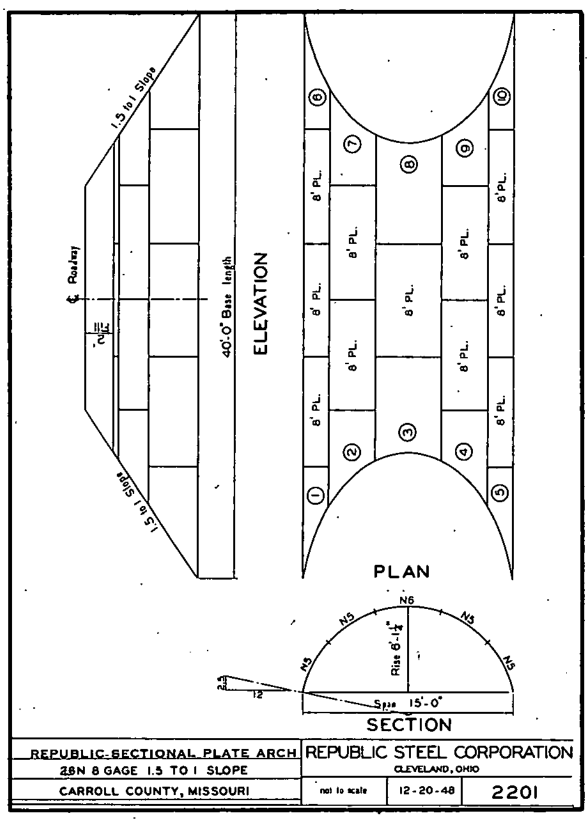
(CONT'D)

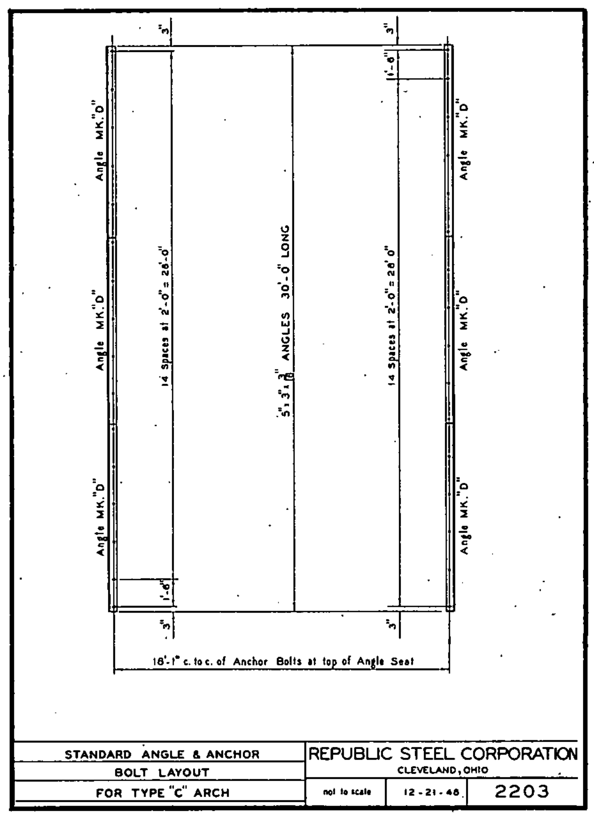
Span (Ft.)	Rise (Ft. & In.)	Opening (Sq. Ft.)	N	R/S	Radius (Inches)
13'	5'- 0¾"	49	22	0.389	80½"
13'	4'- 0¾"	38	20	0.314	86¾"
13'	2'-10½"	26	18	0.221	105½"
14'	7'- 3"	80	28	H.C.	84"
14'	6'- 5¼"	69	26	0.460	84½"
14'	5'- 7"	58	24	0.399	86¼"
14'	4'- 7½"	47	22	0.330	91½"
14'	3'- 5¾"	34	20	0.249	105¼"
15'	7'- 9"	92	30	H.C.	90"
15'	7'- 4¼"	86	29	0.491	90"
15'	6'-11½"	80	28	0.464	90¼"
15'	6'- 1¼"	69	26	0.407	92"
15'	5'- 2"	56	24	0.344	96½"
15'	4'- 1"	43	22,	0.272	107¼"
16'	8'- 3"	106	32	H.C.	96"
16'	7'-10½"	99	31	0.493	96"
16'	7'- 5¾"	92	30	0.467	96¼"
16'	7'- 0¾"	86	29	0.441	96¾"
16'	6'- 7½"	80	28	0.414	97¾"
16'	5'- 8¼"	67	26	0.356	101¾"
16'	4'- 7¾"	53	24	0.291	110½"
17'	8'- 9½"	119	34	H.C.	102"
17'	8'- 4¾"	112	33	0.494	102"
17'	7'-11¾"	105	32	0.470	102¼"
17'	7'- 6¾"	98	31	0.446	102¾"
17'	7'- 1¾"	91	30	0.420	103¾"
17'	6'- 8¼"	85	29	0.394	105"
17'	6'- 2¾"	78	28	0.366	107"
17'	5'- 2½"	63	26	0.307	114½"
18'	9'- 3½"	133	36	H.C.	108"
18'	8'- 6"	118	34	0.473	108¼"
18'	8'- 1"	111	33	0.450	108¾"
18'	7'- 8"	104	32	0.426	109½"
18'	7'- 2½"	97	31	0.401	110¾"
18'	6'- 9"	90	30	0.376	112½"
18'	6'- 3¼"	82	29	0.349	115¼"
18'	5'- 9"	74	28	0.320	119"
19'	9'- 9¾"	149	38	H.C.	114"
19'	9'- 0¼"	133	36	0.475	114¼"
19'	8'- 2"	118	34	0.431	115½"
19'	7'- 8¾"	110	33	0.407	116½"
19'	7'- 3¼"	102	32	0.383	118"
19'	6'- 9½"	95	31	0.358	120½"
19'	6'- 3½"	87	30	0.332	123¾"
19'	5'- 9¼"	78	29	0.304	128½"
20'	10'- 4"	164	40	H.C.	120"
20'	9'- 6¼"	148	38	0.477	120¼"
20'	8'- 8¼"	132	36	0.435	121¼"
20'	7'- 9¾"	116	34	0.391	123¾"
20'	7'- 4"	108	33	0.367	125¾"
20'	6'-10"	99	32	0.342	128¾"
20'	6'- 4"	91	31	0.316	133"
21'	10'-10"	180	42	H.C.	126"
21'	10'- 0½"	164	40	0.479	126¼"
21'	9'- 2½"	147	38	0.439	127¼"
21'	8'- 3"	130	36	0.397	129½"
21'	7'- 4½"	113	34	0.352	134"
21'	6'-10½"	104	33	0.328	137½"
22'	11'- 4¼"	198	44	H.C.	132"
22'	10'-11½"	189	43	0.498	132"+

Span (Ft.)	Rise (Ft. & In.)	Opening (Sq. Ft.)	N	R/S	Radius (Inches)
22'	10'- 6¼"	181	42	0.480	132¼"
22'	9'- 8¼"	163	40	0.442	133"
22'	8'-10¼"	145	38	0.403	135¼"
22'	7'-11"	127	36	0.360	139¼"
22'	6'-10¾"	109	34	0.313	146¾"
22'	6'- 4"	99	33	0.288	152½"
23'	11'-10½"	216	46	H.C.	138"
23'	11'- 5¾"	207	45	0.499	138"+
23'	11'- 0¾"	198	44	0.482	138¼"
23'	10'- 8"	189	43	0.464	138½"
23'	10'- 3"	180	42	0.446	139"
23'	9'- 4½"	161	40	0.408	141"
23'	8'- 5½"	143	38	0.368	144¾"
23'	7'-11½"	133	37	0.346	147½"
23'	7'- 5¼"	123	36	0.324	151¼"
24'	12'- 4½"	236	48	H.C.	144"
24'	11'-11¾"	226	47	0.4996	144"+
24'	11'- 7"	216	46	0.483	144¼"
24'	11'- 2"	207	45	0.466	144½"
24'	10'- 9"	197	44	0.449	145"
24'	10'- 4"	188	43	0.431	145¾"
24'	9'-10¾"	178	42	0.412	146¾"
24'	8'-11¾"	159	40	0.374	150¼"
24'	7'-11¾"	139	38	0.333	156"
24'	6'-10¾"	117	36	0.288	166¾"
25'	12'-10¾"	255	50	H.C.	150"
25'	12'- 6"	245	49	H.C.	150"+
25'	12'- 1¼"	236	48	0.484	150¼"
25'	11'- 8¼"	226	47	0.468	150½"
25'	11'- 3¼"	216	46	0.451	150¾"
25'	10'-10¼"	206	45	0.434	151½"
25'	10'- 5"	196	44	0.417	152½"
25'	9'-11½"	186	43	0.399	153¾"
25'	9'- 6"	175	42	0.380	155¾"
25'	9'- 0¼"	165	41	0.361	158"
25'	8'- 6¼"	155	40	0.341	161"
25'	7'- 5½"	133	38	0.299	170½"
26'	13'- 5"	276	52	H.C.	156"
26'	13'- 0¼"	266	51	H.C.	156"+
26'	12'- 7½"	256	50	0.485	156"+
26'	11'- 9½"	235	48	0.454	156¾"
26'	11'- 4½"	225	47	0.437	157½"
26'	10'-11¼"	214	46	0.421	158¼"
26'	10'- 6"	204	45	0.404	159½"
26'	10'- 0½"	193	44	0.386	161¼"
26'	9'- 6¾"	182	43	0.368	163½"
26'	8'- 0½"	149	40	0.309	174½"
27'	13'-11"	298	54	H.C.	162"
27'	13'- 6½"	287	53	H.C.	162"+
27'	13'- 1½"	276	52	0.486	162"+
27'	12'- 3¾"	255	50	0.456	162¾"
27'	11'- 5½"	233	48	0.424	164"
27'	11'- 0"	222	47	0.408	165½"
27'	10'- 1"	200	45	0.374	169"
27'	9'- 1¼"	178	43	0.337	174¾"
28'	14'- 5½"	320	56	H.C.	168"
28'	14'- 0½"	309	55	H.C.	168"+
28'	13'- 7¾"	298	54	0.487	168"+
28'	12'-10"	276	52	0.458	168½"
28'	11'-11¾"	253	50	0.428	170"
28'	11'- 1"	231	48	0.396	172½"
28'	10'- 7½"	219	47	0.379	174½"
28'	9'- 7¾"	196	45	0.344	179¾"
28'	8'- 7"	172	43	0.307	188½"


PLAN
SECTION
54'-4" Overall length
Rise 6'-9"
Spin 18'-0"
REPUBLIC SECTIONAL PLATE ARCH
STANDARD 30N 5 GAGE
COURTLAND, MICHIGAN
REPUBLIC STEEL CORPORATION
CLEVELAND, OHIO
not to scale
12-20-48
2202

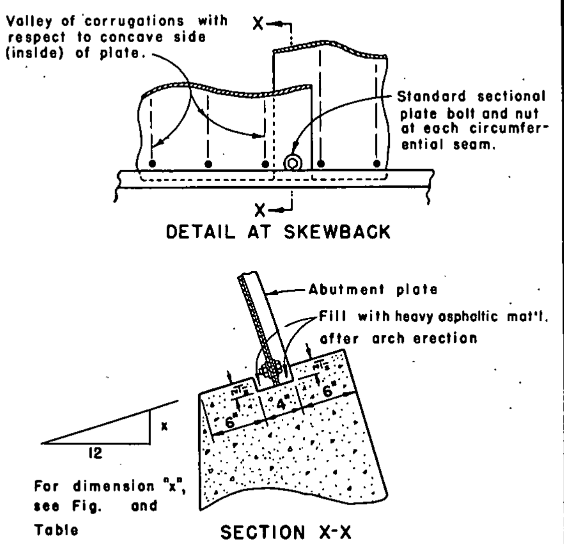

PLAN
SECTION
Length 22'-0"
Roadway
Span 20'-0"
REPUBLIC SECTIONAL PLATE ARCH
34N 5 GAGE 10° SKEW
FULTON COUNTY, ILLINOIS
REPUBLIC STEEL CORPORATION
CLEVELAND, OHIO
not to scale
12-8-48
2200


ELEVATION
PLAN
SECTION
1.5 to 1 Slope
Roadway
40'-0" Base length
Rise 6'-1¼"
Span 15'-0"
REPUBLIC SECTIONAL PLATE ARCH
28N 8 GAGE 1.5 TO 1 SLOPE
CARROLL COUNTY, MISSOURI
REPUBLIC STEEL CORPORATION
CLEVELAND, OHIO
not to scale
12-20-48
2201

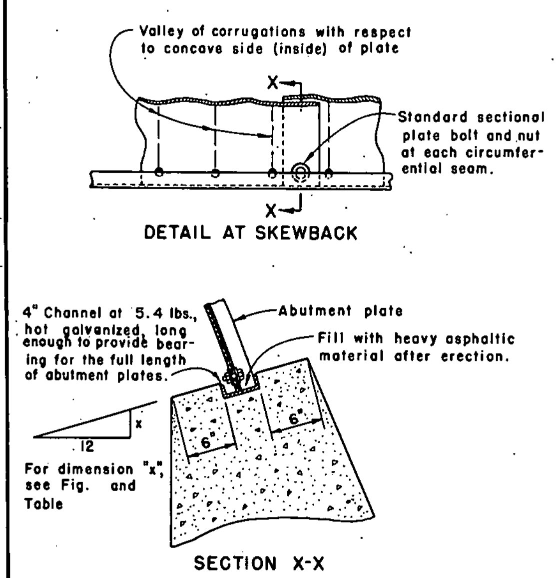

Angle MK."D"
14 Spaces at 2'-0" = 28'-0"
ANGLES 30'-0" LONG
18'-1" c. to c. of Anchor Bolts at top of Angle Seat
STANDARD ANGLE & ANCHOR
BOLT LAYOUT
FOR TYPE "C" ARCH
REPUBLIC STEEL CORPORATION
CLEVELAND, OHIO
not to scale
12-21-48
2203

TYPES OF ABUTMENT CONNECTIONS
For Sectional Plate Arches

TYPE "A"

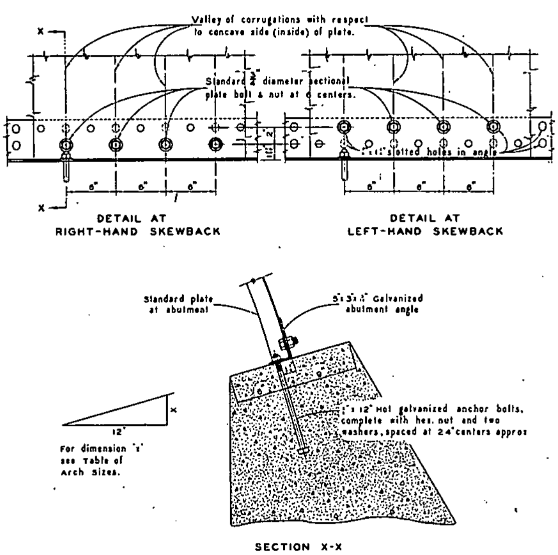


TYPE "B"



Channels are furnished in maximum lengths of 22'-6". Channels of equal length are used for arches over 22'-6" long.

TYPE "C"



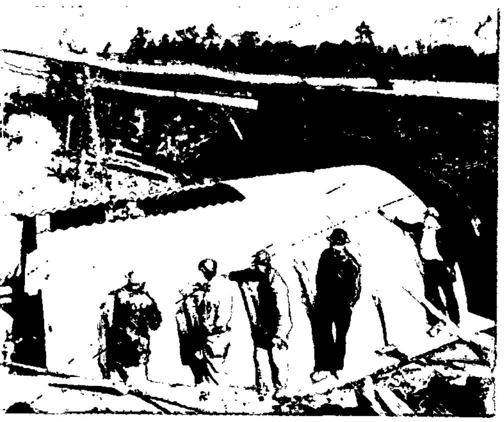
Angles are furnished in lengths of 6'-0", 8'-0", 10'-0" & 12'-0". Plans showing exact spacing of anchor bolts and arrangement of the angles are furnished by the manufacturer

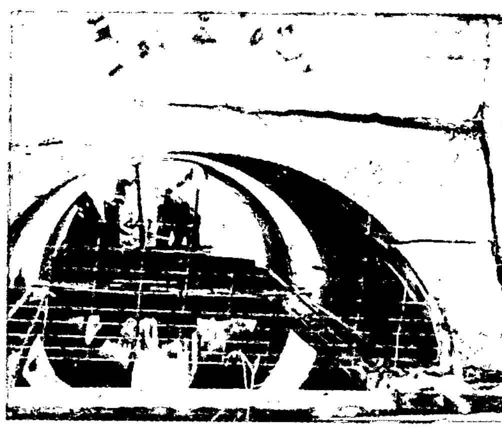
STANDARD GAGES

GAGE	APPROXIMATE THICKNESS
12	7/64"
10	9/64"
8	11/64"
7	3/16"
5	7/32"
3	1/4"
1	9/32"

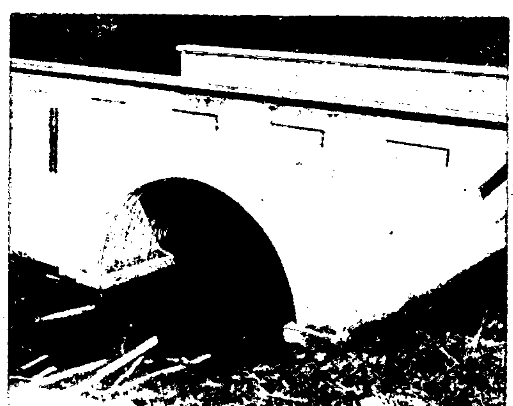
MINIMUM GAGES - REPUBLIC SECTIONAL PLATE ARCHES

Span Feet	H-10 Live Load, Height of Cover									H-15 Live Load, Height of Cover									H-20 Live Load, Height of Cover								
	2′	3′	4′	5′	6′	7′	8′	9′	10′	2′	3′	4′	5′	6′	7′	8′	9′	10′	2′	3′	4′	5′	6′	7′	8′	9′	10′
5	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
7	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
8	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
9	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10
11	12	12	12	12	12	12	12	12	10	12	12	12	12	12	12	12	10	10	10	12	12	12	12	12	12	10	10
12	12	12	12	12	12	12	12	10	10	10	12	12	12	12	12	10	10	10	10	10	12	12	12	12	10	10	10
13	12	12	12	12	12	12	12	10	10	10	10	12	12	12	12	10	10	10	8	8	10	12	12	12	10	10	8
14	10	12	12	12	12	12	12	10	10	8	10	10	12	12	10	10	8	8	8	8	10	10	12	10	10	8	8
15	10	10	12	12	12	12	10	10	10	8	8	8	10	10	10	8	7	7	7	7	8	10	10	10	8	7	7
16	10	10	10	12	12	12	10	8	8	7	8	8	10	10	8	7	7	7	5	7	8	8	10	8	7	7	7
17	10	10	10	10	12	10	10	8	8	7	8	8	8	10	8	7	5	5	5	5	7	8	8	7	5	5	5
18	10	10	10	10	10	10	8	7	7	5	7	8	8	10	8	7	5	3	3	5	7	7	8	7	5	5	3
19	10	10	10	10	10	8	7	5	5	5	5	8	7	8	7	5	3	3	1	3	5	5	8	5	5	3	3
20	10	10	10	10	10	8	5	5	3	3	5	7	7	8	5	3	3	1	1	1	3	5	7	5	3	1	1
21	8	10	10	10	10	7	5	3	1	1	3	5	5	7	3	3	1			1	3	3	5	3	3	1	
22	7	8	8	8	8	5	3	1	1	1	3	3	3	5	3	1					1	3	5	3	1		
23	5	7	7	7	7	3	1	1			1	3	1	3	1							1	3	1			
24	3	5	5	7	7	5	3	1				1	1	3	1								1				
25	1	3	3	5	5	3	1						1	1													
26		1	1	3	3	1																					
27			1	1	1	1																					
28				1	1																						

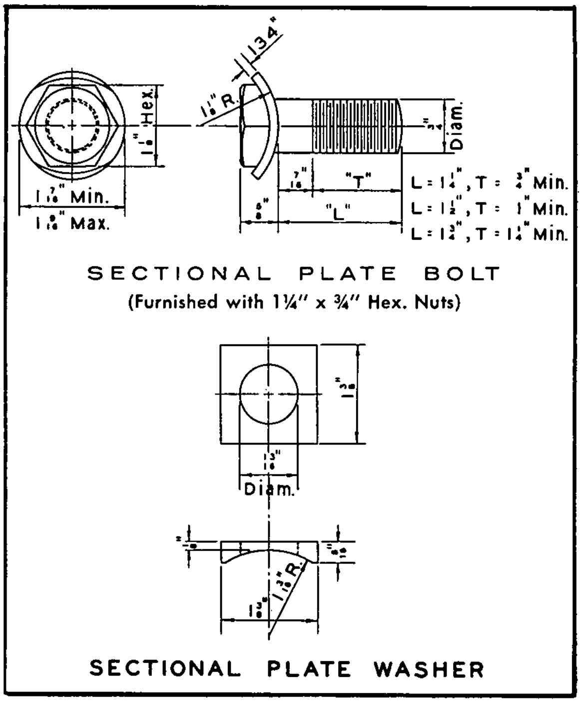




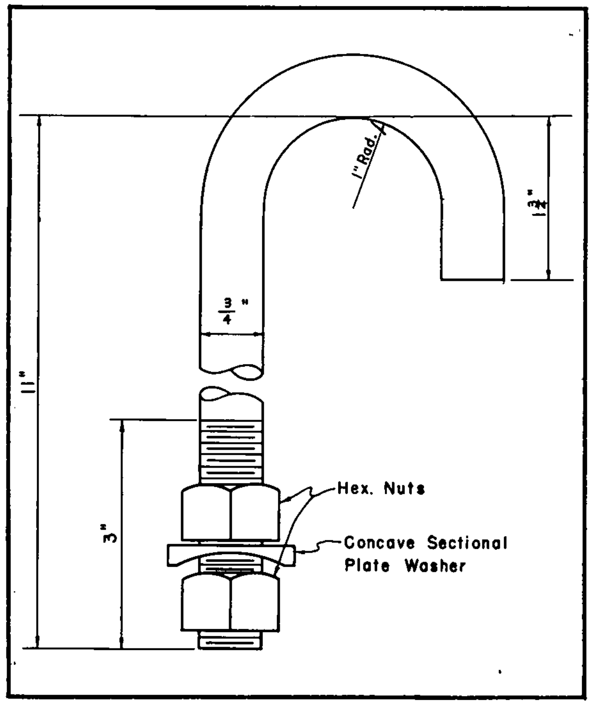
These pictures show steps in the repair of a not too old but failed rigid structure. A Republic Sectional Plate Arch, Type B, 20 feet long, with a 164-inch span and a 73-inch rise, five-plate, three-gage, was erected right in the stream bed and pulled under the old bridge. It was then grouted into place and the road surface refinished.



SPECIAL BOLTS FOR USE WITH SECTIONAL PLATE PRODUCTS

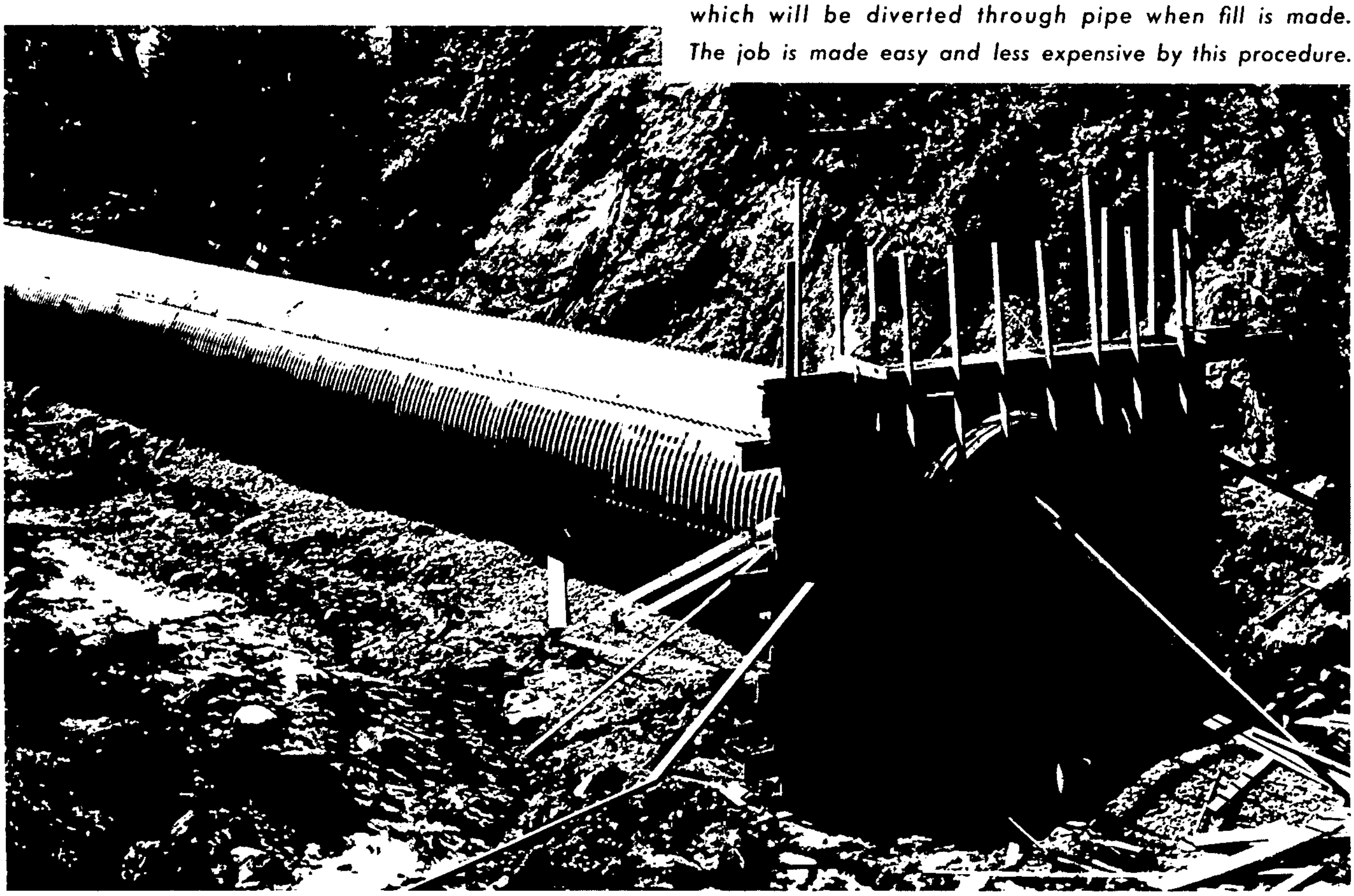


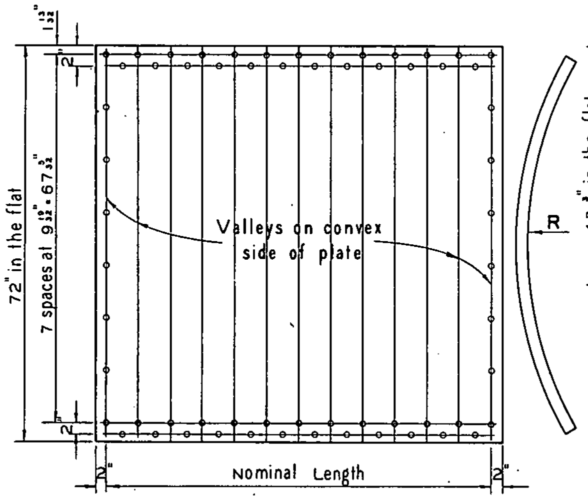
Details of Standard Sectional Plate Bolt and Washer



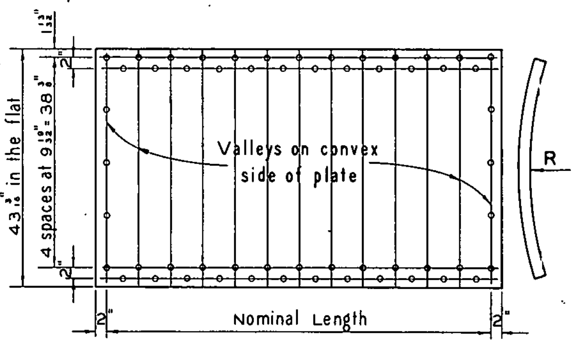
Standard Hook Bolt for Sectional Plates

Republic Sectional Plate Pipe is assembled beside stream which will be diverted through pipe when fill is made. The job is made easy and less expensive by this procedure.

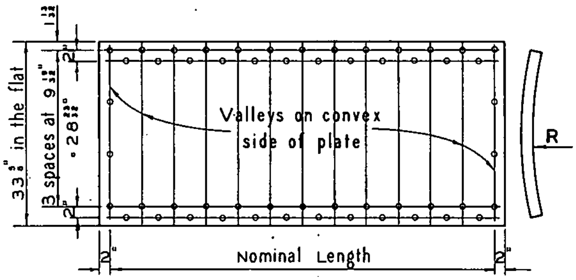




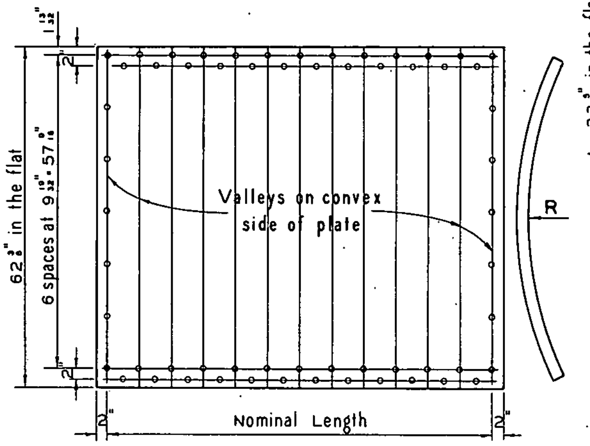
N7 PLATE



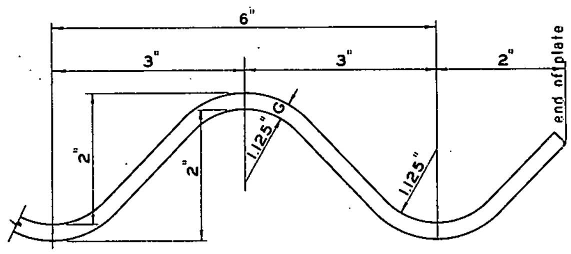
N4 PLATE



N3 PLATE



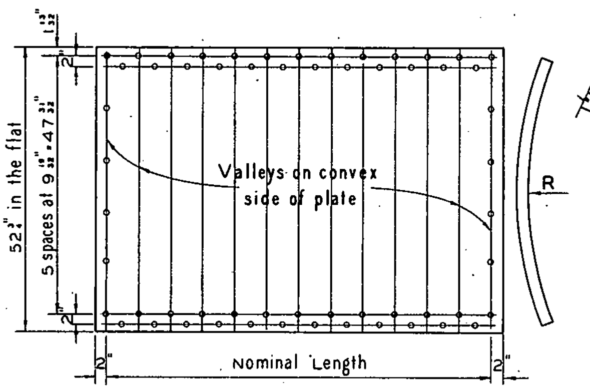
N6 PLATE



STANDARD CORRUGATION

Plates are shown punched for 4 bolts per foot of longitudinal seam. They may be punched for either 6 or 8 bolts per foot if required.

All bolt holes are ⅞" diameter for ¾" diameter bolts.



N5 PLATE

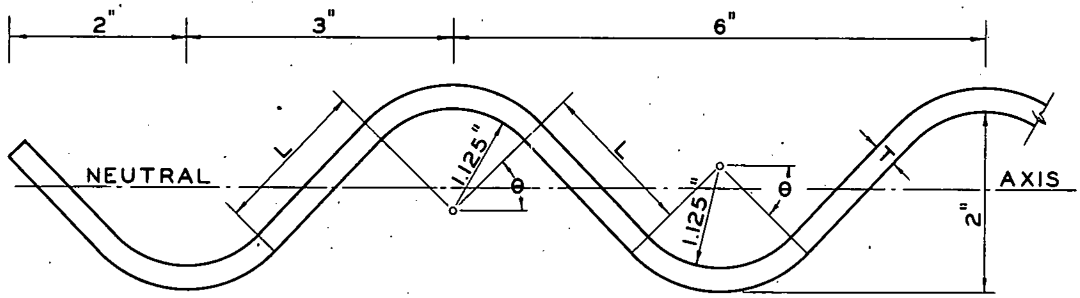
APPROXIMATE WEIGHT OF REPUBLIC SECTIONAL PLATE

Width	Length	WEIGHT IN POUNDS OF GALVANIZED PLATES EXCLUSIVE OF BOLTS							REQUIRED ¾" x 1½" BOLTS NUTS & WASHERS	
		GAGE NUMBER								
		1	3	5	7	8	10	12	Number *	Pounds
N 7	8'	723	644	565	486	...	...	...	38	20.0
N 7	6'	548	488	428	368	...	...	...	30	15.8
N 6	8'	626	558	489	421	387	318	250	37	19.5
N 6	6'	475	423	371	319	293	241	189	29	15.3
N 5	8'	530	472	414	356	327	269	211	36	18.9
N 5	6'	402	358	314	270	248	204	160	28	14.7
N 4	8'	434	386	339	291	268	220	173	35	18.4
N 4	6'	329	293	257	221	203	167	131	27	14.2
N 3	8'	338	301	264	227	208	172	135	34	17.9
N 3	6'	256	228	200	172	158	130	102	26	13.7

* Includes 4 bolts, 1¼" long for holes at corners of plates in 1, 3, 5, and 7 gage.

DETAILS OF REPUBLIC SECTIONAL PLATES

DIMENSION & DESIGN PROPERTIES OF REPUBLIC SECTIONAL PLATE



Gage	Foot Weight (# Sq. Ft.)	Thickness "T" (Inches)	Tangent Length "L" (Inches)	Angle θ (Degrees)	I* Moment of Inertia in 4/inch	S* Section Modulus in 3/inch	A* Area of Section in 2/inch
1	11.475	0.2744	1.7037	43°-56′	0.16488	0.1450	0.3415
3	10.200	0.2439	1.7391	44°-14′	0.14538	0.1296	0.3033
5	8.925	0.2134	1.7738	44°-32′	0.12624	0.1141	0.2652
7	7.650	0.1829	1.8080	44°-50′	0.10741	0.0984	0.2271
8	7.013	0.1677	1.8246	44°-58′	0.09814	0.0905	0.2082
10	5.738	0.1372	1.8577	45°-14.5′	0.07976	0.0746	0.1702
12	4.463	0.1067	1.89025	45°-31′	0.06166	0.0585	0.13230

Values indicated are for one inch of horizontal projection.

STRUCTURE LENGTHS

TYPICAL 6′ AND 8′ PLATE COMBINATIONS REQUIRED FOR VARIOUS LENGTHS OF SECTIONAL PLATE STRUCTURES

Alternate rows are of different combinations to stagger circumferential seams

Length Feet	6′ Plates	8′ Plates	Length Feet	6′ Plates	8′ Plates
6′	1	0	64′	0	8
8′	0	1	66′	3	6
10′	. .	. .	68′	2	7
12′	2	0	70′	1	8
14′	1	1	72′	0	9
16′	0	2	74′	3	7
18′	3	0	76′	2	8
20′	2	1	78′	1	9
22′	1	2	80′	0	10
24′	0	3	82′	3	8
26′	3	1	84′	2	9
28′	2	2	86′	1	10
30′	1	3	88′	0	11
32′	0	4	90′	3	9
34′	3	2	92′	2	10
36′	2	3	94′	1	11
38′	1	4	96′	0	12
40′	0	5	98′	3	10
42′	3	3	100′	2	11
44′	2	4	102′	1	12
46′	1	5	104′	0	13
48′	0	6	106′	3	11
50′	3	4	108′	2	12
52′	2	5	110′	1	13
54′	1	6	112′	0	14
56′	0	7	114′	3	12
58′	3	5	116′	2	13
60′	2	6	118′	1	14
62′	1	7	120′	0	15

TYPICAL PLATE ARRANGEMENTS

Diameters, Spans, and Rises, as well as costs and weights of Plate Structures, are a function of the circumferential size as represented by the Total N.

Plate Width Combinations to provide the specified total N will usually be furnished in accordance with the following table.

Total	1, 3, 5, and 7 Gage Plates				8, 10, and 12 Gage Plates			
N	N7	N6	N5	N3	N6	N5	N4	N3
3				1				1
4							1	
5			1			1		
6		1			1			
7	1						1	1
8			1	1		1		1
9		1		1	1			1
						1	1	
10			2			2		
	1			1	1		1	
11		1	1		1	1		
			1	2			2	1
12		2			2			
	1		1				3	
13	1	1				1	2	
			2	1	1		1	1
14	2				1	1		1
		1	1	1		2	1	
15			3			3		
		2		1	1	1	1	
16		1	2		1	2		
	1	1		1	2		1	
17		2	1		2	1		
	1		2			1	3	
18		3			3			
	1	1	1			2	2	
19	2		1			3	1	
	1	2			1	1	2	
20	2	1				4		
		4			2		2	
21	3				1	3		
		1	3		2	1	1	
22	1		3		2	2		
		2	2		3		1	
23	1	1	2		3	1		
		3	1		1	1	3	
24		4			4			
	2		2			4	1	
25	2	1	1			5		
	1	3			1	3	1	
26	2	2			1	4		
	3		1		2	2	1	
27	3	1			2	3		
	1		4		3	1	1	
28	4				3	2		
	1	1	3		4		1	
29		4	1		4	1		
	2		3			5	1	
30		5			5			
	1	3	1			6		
31	1	4			1	5		
	3		2		2	3	1	
32	2	3			2	4		
	3	1	1		3	2	1	
33	3	2			3	3		
	4		1		4	1	1	
34	4	1			4	2		
	2		4		5		1	
35	5				5	1		
	2	1	3			7		
36		6			6			
	3		3		1	6		
37	1	5			2	5		
	3	1	2		4	1	2	
38	2	4			3	4		
	4		2		5		2	
39	3	3			4	3		
	4	1	1		5	1	1	
40	4	2			5	2		
	5		1			8		
41	5	1			6	1		
	3		4		1	7		
42	6				7			
		7			2	6		
43	1	6			3	5		
	3	2	2		4	3	1	
44	2	5			4	4		
	3	3	1		5	2	1	
45	3	4			5	3		
	4	2	1		6	1	1	
46	4	3			6	2		
	5	1	1		7		1	
47	5	2			7	1		
	6		1		2	7		
48	6	1			8			
	3	2	3		3	6		
49	7				4	5		
	1	7			5	3	1	
50	2	6			5	4		
	4	2	2		6	2	1	
51	3	5			6	3		
	4	2	1		7	1	1	
52	4	4			7	2		
	5	2	1		8		1	
53	5	3			8	1		
	6	1	1		3	7		
54	6	2			9			
	7		1		4	6		
55	7	1			5	5		
	1	8			6	3	1	
56	8				6	4		
	2	7			7	2	1	
57	3	6			7	3		
	5	2	2		8	1	1	
58	4	5			8	2		
	6	1	2		9		1	
59	5	4			9	1		
	6	2	1		4	7		
60	6	3			10			
	7	1	1		5	6		

DETERMINATION OF WATERWAY OPENING

TALBOT'S FORMULA

AREA OF WATERWAY (SQ. FT.) $= C\sqrt[4]{(\text{DRAINAGE AREA IN ACRES})^3}$

1 SQ. MILE = 640 ACRES **1 ACRE = 43,560 SQ. FEET**

DRAINAGE AREA		AREA OF WATERWAY (SQUARE FEET)				
Acres	Sq. Mi.	C = 1.0	C = 0.7	C = 0.5	C = 0.3	C = 0.2
200	0.31	53.2	37.2	26.6	15.9	10.7
220	0.34	57.1	40.0	28.5	17.1	11.4
240	0.38	61.0	42.7	30.5	18.3	12.2
260	0.41	64.7	45.3	32.4	19.4	12.9
280	0.44	68.1	47.7	34.1	20.4	13.6
300	0.47	72.1	50.4	36.1	21.6	14.4
320	0.50	75.7	53.0	37.9	22.7	15.1
340	0.53	79.2	55.4	39.6	23.8	15.8
360	0.56	82.6	57.8	41.3	24.8	16.5
380	0.59	86.1	60.3	43.2	25.8	17.2
400	0.62	89.4	62.6	44.7	26.8	17.9
450	0.70	97.7	68.4	48.9	29.3	19.5
500	0.78	105.7	74.0	52.9	31.7	21.1
550	0.86	113.6	79.6	56.8	34.1	22.7
600	0.94	121.2	84.9	60.6	36.4	24.2
640	1.00	127.2	89.1	63.6	38.2	25.4
768	1.20	145.9	102.0	73.0	43.8	29.2
896	1.40	163.8	114.6	81.9	49.2	32.8
1024	1.60	181.1	127.2	90.6	54.6	36.2
1152	1.80	197.7	138.4	98.9	59.3	39.6
1280	2.00	214.0	149.8	107.0	64.2	42.8
1408	2.20	229.9	160.9	114.9	69.0	46.0
1536	2.40	245.4	171.8	122.7	73.6	49.1
1664	2.60	260.5	182.4	130.3	78.2	52.1
1792	2.80	275.4	192.8	137.7	82.6	55.1
1920	3.00	290.0	203.0	145.0	87.0	58.0
2240	3.50	325.6	227.9	162.8	97.7	65.1
2560	4.00	359.9	252.0	179.9	108.0	71.9
2880	4.50	393.1	275.2	196.6	117.9	78.6
3200	5.00	425.5	297.9	212.8	127.7	85.1
3520	5.50	457.0	319.9	228.5	137.1	91.4
3840	6.0	487.8	341.5	243.9	146.3	97.5
4160	6.5	518.0	362.6	259.0	155.4	103.6
4480	7.0	547.6	383	274	164	110
4800	7.5	576.7	404	288	173	115
5120	8.0	605.3	424	303	182	121
5440	8.5	633.5	443	317	190	127
5760	9.0	661.2	463	331	198	132
6080	9.5	688.5	482	344	207	138
6400	10.0	715.6	500	358	215	143
7680	12.0	820.4	574	410	246	164
9600	15.0	969.8	679	485	291	194

For area of waterway required when using other values of "C," multiply value of "C" to be used by figures shown in Column C = 1.0.

With the Talbot Formula the following values for "C" may be used in sections where a maximum twenty-four-hour rainfall of 4" might be expected to occur on an average of once in every fifteen years.

C = 1.0, for rocky ground with steep and abrupt slopes.

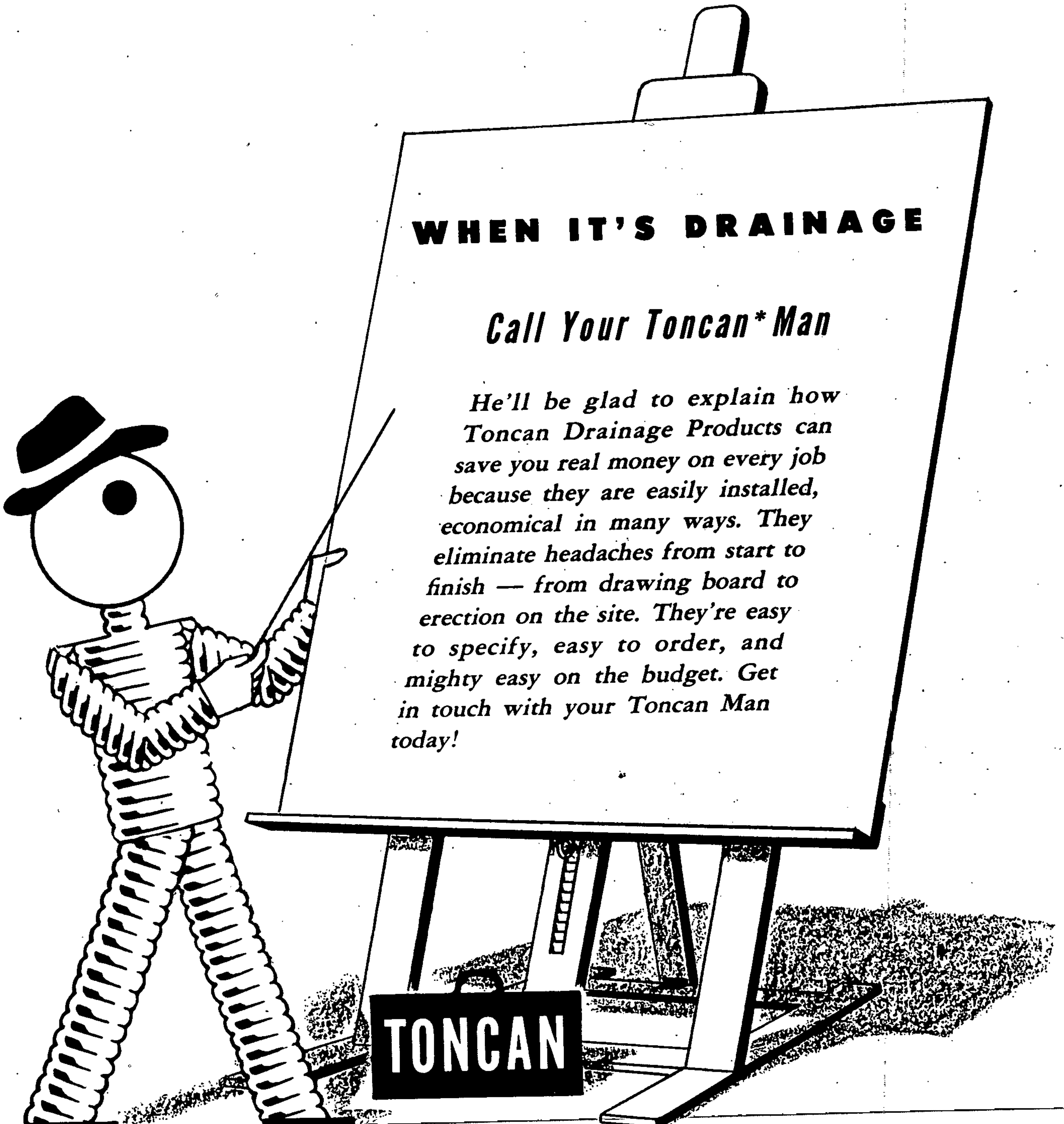
C = 0.7, for rough, hilly land of moderate slopes.

C = 0.5, for wide uneven valley.

C = 0.3, for rolling agricultural country with the valley three or four times longer than it is wide.

C = 0.2, for level country not affected by snow accumulation or flood action.

The factor "C" may be increased or decreased proportionately depending upon topography and rainfall.



*Toncan is the registered trade mark of Republic Steel Corporation

LOGANSPORT METAL CULVERT CO.

LOGANSPORT, INDIANA

PHONE: 5157

TCM-482R—5M—3-55

Litho in U. S. A.

LOGANSPORT METAL CULVERT CO.

220 Hanna Street

LOGANSPORT, INDIANA

PRICE – DELIVERED

CORRUGATED METAL PIPE

DIA.	16 GAUGE STEEL	16 GAUGE IRON OR KONIK	14 GAUGE STEEL	14 GAUGE IRON OR KONIK	12 GAUGE STEEL	12 GAUGE IRON OR KONIK	10 GAUGE STEEL	10 GAUGE IRON OR KONIK	8 GAUGE STEEL	8 GAUGE IRON OR KONIK	DIA.
8"	1.37*	1.44*									8"
10"	1.58*	1.66*	1.95	2.05							10"
12"	1.80*	1.89*	2.19	2.30	3.06	3.21					12"
15"	2.14*	2.25*	2.63	2.76	3.65	3.83					15"
18"	2.49*	2.61*	3.06	3.21	4.26	4.47					18"
21"	2.83*	2.97*	3.49	3.66	4.86	5.10	6.25	6.56			21"
24"	3.27	3.43	4.03*	4.23*	5.60	5.88	7.19	7.55			24"
30"			4.91*	5.16*	6.80	7.14	8.75	9.19	10.46	10.98	30"
36"			5.90	6.20	8.05*	8.45*	10.42	10.94	12.44	13.06	36"
42"			7.00	7.35	9.62*	10.10*	12.33	12.95	14.68	15.41	42"
48"					11.03*	11.58*	14.11	14.82	16.78	17.62	48"
54"					13.26*	13.92*	16.82	17.66	19.97	20.97	54"
60"					14.83	15.57	19.02*	19.97*	22.48	23.60	60"
66"							20.66*	21.69*	24.68	25.91	66"
72"							22.66*	23.79*	26.93	28.28	72"
78"							24.99	26.24	29.58*	31.06*	78"
84"									32.54*	34.17*	84"
90"									36.97	38.82	90"
96"									40.97	43.02	96"

*Indicates State Specification gages.

<u>CONNECTING BANDS:</u>
7" and 12" wide; same as one foot of pipe.
24" wide - same as two feet of pipe.
Gage and grade of pipe ordered determines price of band.

<u>PERFORATED PIPE:</u> Add 1/2¢ per inch of nominal diameter for plain galvanized. Add 1¢ per inch of nominal diameter for coated and/or paved.

<u>DOUBLE BITUMINOUS COATED:</u> Add to plain pipe price 2¢ per inch of nominal diameter.

<u>PAVED AND HALF COATED:</u> Add 3¢ per inch of nominal diameter.

<u>PAVED AND COATED</u>: Add 4¢ per inch of nominal diameter.

<u>PIPE-ARCH</u>: Add 7% to pipe, complete with all extras.

<u>STRUTTING EXTRA:</u> Add 15% to price of plain pipe for wire strutting. Add 25% for strutting with rods and angles.

Phone Logansport 5157

LOGANSPORT METAL CULVERT COMPANY
220 Hanna Street
LOGANSPORT, INDIANA

CORRUGATED METAL PIPE ARCH

Prices per Foot - Delivered

		Galvanized					Double Bituminous Coated					Paved and Coated				
Dia.	P.A.	16 Ga.	14 Ga.	12 Ga.	10 Ga.	8 Ga.	16 Ga.	14 Ga.	12 Ga.	10 Ga.	8 Ga.	16 Ga.	14 Ga.	12 Ga.	10 Ga.	8 Ga.
15	18x11	2.29*	2.81	3.91			2.61*	3.13	4.21			2.93*	3.45	4.55		
18	22x13	2.66*	3.27	4.56			3.05*	3.66	4.95			3.44*	4.05	5.34		
21	25x16	3.03*	3.73	5.20	6.69		3.48*	4.18	5.65	7.14		3.93*	3.63	4.10	7.59	
24	29x18	3.50	4.31*	5.99	7.69		4.01	4.83*	6.50	8.20		4.52	5.34*	7.01	8.71	
30	36x22		5.25*	7.28	9.36	11.19		5.90*	7.92	10.00	11.83		6.54*	8.56	10.64	12.47
36	43x27		6.31	8.61*	11.15	13.31		7.08	9.38*	11.92	14.08		7.85	10.15*	12.69	14.75
42	50x31		7.49	10.29*	13.19	15.71		8.39	11.19*	14.09	16.61		9.29	12.09*	14.99	17.51
48	58x36			11.80*	15.10	17.95			12.83*	16.13	18.98			13.86*	17.16	20.01
54	65x40			14.19*	18.00	21.37			15.34*	19.16	22.53			16.51*	20.32	23.69
60	72x44			15.87	20.35*	24.05			17.15	21.64*	25.33			18.43	22.92*	26.61

* Indicates Standard Gage

Double Bituminous Coated: Plain pipe price plus 2¢ per inch of nominal diameter, plus 7%.

Paved and Coated: Plain pipe price plus 4¢ per inch of nominal diameter, plus 7%.

Logansport, Indiana, Phone 5157

LOGANSPORT METAL CULVERT CO.
220 Hanna Street
LOGANSPORT, INDIANA

SELLING PRICES PER LINEAL FOOT OF STRUCTURE - Unassembled
REPUBLIC SECTIONAL PLATE PIPE ARCH-Unassembled and not Erected- F.O.B. Destination

			Selling Price per Foot of Structure including Bolts						
Span	Height	N	12 Ga.	10 Ga.	8 Ga.	7 Ga.	5 Ga.	3 Ga.	1 Ga.
6'1"	4'7"	22	23.20	26.83	30.46	32.19	36.74	40.70	43.42
6'4"	4'9"	23	23.93	27.70	31.53	33.34	38.02	42.14	44.98
6'9"	4'11"	24	24.66	28.61	32.57	34.46	39.28	43.59	46.35
7'0"	5'1"	25	25.39	29.50	33.62	35.57	40.55	45.03	47.71
7'3"	5'3"	26	27.56	31.85	36.16	38.22	43.60	48.33	51.68
7'8"	5'5"	27	28.29	32.75	37.23	39.27	44.89	49.77	52.93
7'11"	5'7"	28	29.03	33.64	38.27	40.49	46.14	51.21	54.30
8'2"	5'9"	29	29.73	34.49	39.26	41.52	47.37	52.56	55.97
8'7"	5'11"	30	31.90	36.84	41.82	44.19	50.42	55.86	59.63
8'10"	6'1"	31	32.63	37.76	42.87	45.32	51.71	57.30	61.19
9'4"	6'3"	32	33.38	38.64	43.93	46.45	52.98	58.75	62.56
9'6"	6'5"	33	34.10	39.53	44.98	47.57	54.23	60.17	63.92
9'9"	6'7"	34	34.83	40.41	46.02	48.69	55.51	61.61	65.29
10'3"	6'9"	35	35.56	41.31	47.09	49.83	56.79	63.05	66.84
10'8"	6'11"	36	36.27	42.14	48.07	50.84	57.99	64.40	68.31
10'11"	7'1"	37	37.00	43.04	49.14	51.99	59.27	65.84	69.87
11'5"	7'3"	38	37.74	43.96	50.19	53.13	60.56	67.29	71.42
11'7"	7'5"	39	39.88	46.27	52.67	55.69	63.53	70.49	75.21
11'10"	7'7"	40	40.61	47.15	53.71	56.81	64.81	71.94	76.57
12'4"	7'9"	41	41.34	48.03	54.76	57.92	66.08	73.48	77.93
12'6"	7'11"	42	42.07	48.92	55.80	59.04	67.33	74.80	79.30
12'8"	8'1"	43	42.81	49.83	56.89	60.22	68.65	76.26	81.05
12'10"	8'4"	44	43.54	50.70	57.92	61.30	69.89	77.69	82.23
13'5"	8'5"	45	45.69	53.06	60.47	63.95	72.94	80.99	85.90
13'11"	8'7"	46	46.42	53.94	61.52	65.08	74.20	82.43	87.27
14'1"	8'9"	47	47.17	54.85	62.57	66.23	75.49	83.87	88.32
14'3"	8'11"	48	47.90	55.75	63.64	67.36	76.77	85.31	90.38
14'10"	9'1"	49	48.61	56.61	64.64	68.42	78.00	86.66	92.04
15'4"	9'3"	50	49.35	57.51	65.79	69.55	79.28	88.12	93.60
15'6"	9'5"	51	51.48	59.80	68.15	72.08	82.24	91.31	97.17
15'8"	9'7"	52	52.22	60.71	69.24	73.25	83.55	92.77	98.93
15'10"	9'10"	53	52.95	61.60	70.29	74.37	84.82	94.19	100.30
16'5"	9'11"	54	53.68	62.50	71.33	75.49	86.09	95.64	101.66
16'7"	10'1"	55	54.41	63.36	72.37	76.63	87.33	97.06	102.84

LOGANSPORT METAL CULVERT CO.

220 Hanna Street

LOGANSPORT, INDIANA

SELLING PRICES REPUBLIC SECTIONAL PLATE PIPE
Unassembled and Not Erected
F.O.B. Destination

Pipe Dia. Inches	12 Ga.	10 Ga.	8 Ga.	7 Ga.	5 Ga.	3 Ga.	1 Ga.
60	$ 20.27	$ 23.53	$ 26.78	$ 28.30	$ 32.35	$ 35.88	$ 38.50
66	21.75	25.31	28.89	30.55	34.88	38.75	41.23
72	23.22	27.11	31.02	32.84	37.45	41.65	44.35
78	24.68	28.88	33.11	35.08	39.97	44.52	47.07
84	26.15	30.69	35.25	37.37	42.55	47.40	50.19
90	30.43	35.31	40.19	42.47	48.52	53.82	57.74
96	31.88	37.08	42.28	44.70	51.04	56.70	60.47
102	33.36	38.87	44.41	47.00	53.61	59.58	63.58
108	34.80	40.61	46.47	49.18	56.11	62.43	65.92
114	36.27	42.42	48.61	51.48	58.68	65.33	69.04
120	37.76	44.22	50.73	53.75	61.26	68.22	72.15
126	39.23	46.02	52.87	56.05	63.83	71.11	75.27
132	43.49	50.64	57.82	61.15	69.80	77.52	82.83
138	44.93	52.37	59.86	63.33	72.28	80.38	85.17
144	46.44	54.22	62.03	65.67	74.90	83.28	88.68
150	47.88	55.96	64.09	67.86	77.38	86.15	91.02
156	49.37	57.80	66.26	70.20	80.00	89.05	94.52
162	50.82	59.57	68.36	72.45	82.52	91.92	97.25
168	52.30	61.36	70.49	74.74	85.10	94.81	100.36
174	56.58	65.98	75.44	79.83	91.06	101.23	107.93
180	58.00	67.69	77.45	81.96	93.51	104.07	109.88

SELLING PRICES SECTIONAL PLATE CATTLEPASSES

Span	Height	12 Ga.	10 Ga.	8 Ga.	7 Ga.	5 Ga.	3 Ga.	1 Ga.
5'10"	6'6"	27.56	31.87	36.18	38.25	43.62	48.33	51.57
5'10"	7'7"	31.19	35.99	40.83	43.14	49.20	54.50	57.97

LOGANSPORT METAL CULVERT CO.
220 Hanna Street
LOGANSPORT, INDIANA

SELLING PRICES REPUBLIC SECTIONAL PLATE PIPE, ARCHES, PIPE-ARCHES, ACCESSORIES AND EXTRAS

ACCESSORIES

Extra Bolts and Nuts: Concave Washers Length	3/4 Diameter, Galv. Cost Each
1¼"	$ 0.23
1½"	0.24
1 3/4"	0.25
2"	0.26
3"	0.29
3/4" Nuts only	0.10

Hook Bolts: 3/4" or 11" Galvanized hook bolts complete with one (1) concave washer and two (2) hex nuts $ 1.13 ea.

EXTRAS

Skewed and/or Beveled Ends: See separate price sheet

Extra Bolt Holes: No extra charge will be made for 6 and 8 holes per foot of seam. Extra holes in any plate, which because of size or location, cannot be punched in the regular corrugating and punching operation, will be furnished at $0.45 per hole. (Hole not to exceed 7/8" diameter.) Extra bolts will be charged as shown above.

Extra Holes for Hook Bolts: Extra holes for hook bolts - $0.55 each.

Extra for Asphalt Coating: Add 20% to price of structure.

Standard Galvanized Unbalanced Channels when Required: $2.03

Heavier Invert: Add price per "N" foot for gage required for bottom plates.

LOGANSPORT METAL CULVERT CO.
220 Hanna Street
LOGANSPORT, INDIANA

PRICES CORRUGATED METAL BRIDGE PLANK
Selling Prices F.O.B. nearest rail point.

State	Price per Square Foot Including Punching								
	12 Gage			10 Gage			7 Gage		
	1300 Sq.Ft. or Less	1300 to 6400 Sq.Ft.	Over 6400 Sq.Ft.	1300 Sq.Ft. or Less	1300 to 5000 Sq. Ft.	Over 5000 Sq. Ft.	1300 Sq.Ft. or less	1300 to 3740 Sq. Ft.	Over 3740 Sq.Ft.
Indiana	$1.07	1.02	0.94	1.36	1.29	1.20	1.84	1.75	1.62

Bridge Plank is given one coat of highly weatherproof red shop primer after fabrication. Detailed paint specifications will be furnished on request.

Material: ASTM-245-48T, Grade C.

Area for Pricing Purposes: Compute the area by using the covering width in multiples of one foot and the covering length of multiples of two feet. Where the actual width is not an even multiple of one foot, use the next greater multiple of one foot. Where the actual length is not an even multiple of two feet, use the next greater multiple of two feet.

Example 1. Dimensions of Bridge Floor, 19'3" wide by 30'-3" long.
Area for pricing purposes, 20' wide x 52' long - 1040 sq. ft.

2. Dimensions of Bridge Floor, 18'-0" wide by 54'-0" long
Area for pricing purposes, 18' wide by 54' long - 972 sq. ft.

EXTRAS AND ACCESSORIES

For skewed planks	$ 2.86 per cut
10 gage end dams welded to plate	2.20 per end
10 gage end dams, loose, 24" long	0.41 each
10 gage end dams, loose, 144" long	2.41 each

TERMS: Direct sales to political units are 30 days net. Contractors, jobbers and general purchasers ½ of 1%, for cash in 10 days, 30 days net.

LOGANSPORT METAL CULVERT CO.
220 Hanna Street
LOGANSPORT, INDIANA

BEAM TYPE GUARDRAIL

Delivered Prices, F.O.B. Cars, Nearest Railroad Point

State	12 Gage - 7.71 lbs per ft.			10 Gage - 9.84 lbs. per ft.		
	1300' or Less	Over 1300' Less than 5200'	5200' or More	1300' or Less	Over 1300' Less than 4100'	4100' or more
Indiana	1.27	1.20	1.15	1.50	1.45	1.35

Price per Lineal Foot of Net Laying Length

STANDARD EXTRAS, ACCESSORIES AND TERMS

End Wings:
With necessary bolts, 10 gage, 19.5 lbs . . . . $ 4.40 each

Intermediate Holes:
With the necessary post bolt, nut and washer . . . . 0.92 each

Extra Bolts:

5/8" x 1¼"	Galvanized Machine Bolt and Nut	0.15 each
5/8" x 2"	Galvanized Machine Bolt and Nut	0.16 each
5/8" x 5"	Galvanized Machine Bolt and Nut	0.24 each
5/8" x 8"	Galvanized Machine Bolt and Nut	0.29 each
5/8" x 10½"	Galvanized Machine Bolt and Nut	0.30 each
5/8" x 14"	Galvanized Machine Bolt and Nut	0.40 each
5/8" Galvanized Cut Washer		0.05 each

Curving:
(Minimum radius 20') $0.40 per foot of net laying length.

Paint:
Both guardrail and end wings are given one coat of highly weatherproof, red shop primer. Detailed paint specifications can be secured upon request.

Shipments from Stock:
Add 5% to above prices on all shipments from stock at plant.

Terms:
Direct sales to governmental and political units are net 30 days. Contractors, jobbers and general purchasers 1/2 of 1% for cash in 10 days, 30 days net.

Specifications
for
RETAINING WALL
at
8th St. an d College Ave.
Bloomington, Indiana.

INTENTIONS

The site of the work comtemplated by these specifications is located at 8th Street and College Avenue in the City of Bloomington, Indiana and upon the premises of the Palmer Realty Company and occupied by the A and P Grocery Compan y. It is the intent of these specifications to provide for the furnishing of all labor, equipment and materials hereinafter specified, and for the performan ce of all work required to co nstruct a concrete retaining wall and properly grade an alley, all as shown on the plans accompanying these specifications. Also, included in this work is the removal and disposal of the existing stone wall located on the site of the proposed concrete wall. These specifications shall be used in connection with and be co nsidered a part of all detailed specifications and the specifications shall be considered a part of the contract or obligations.

The work "OWNER" as used in these specifications shall be understood as referring to the Palmer Realty Company.

The work "ENGINEER" as used in these specifications shall be understood as referring to John T. Stapleton.

The work "CONTRACTOR" as used in these specifications shall be understood as referring to the person, firm or corporation who shall enter into an agreement to execute and perform the work, or any part thereof, as herein specified and comtemplated.

In case the plan s an d specifications are deficient in any part or not clearly expressed, bidders desiring to submit propositions shall apply to the Engineer for information before submitting thier propositions. Bidders shall examined for themselves the location of the proposed work, and exercise their own judgement as to the nature and amount of work to be don e. If it is found that an ything has been omitted or mis-stated, which is necessary, for the proper performance and completion of the work , or any part of the work comtemplated herein, inaccordance with the spirit of the plans an d specifications, the contractor will be required to execute and perform the same as though fully and correctly stated, and the ~~contractor~~ corrections of an y error or ommission shall n ot be deemed an addition to, alteration of, or deviation from the work herein comtemplated an d contracted for.

STAKING OUT WORK

The work to be don e under this contract will be staked out by the Engineer. The Contractor shall give the Engineer twenty-four (24) hours notice before requiring stakes to be set on any portion of the work. He should also give notice to all authorized superintendents of all utuilities that will affected by his operations. The Contractor must satisfy himself before starting the work as to the meaning and correctness of all stakes and marks. The Contractor will be held respondsible for the preservation of all such stakes and marks in their proper position.

ASSISTANCE

The Contractor is to furnish the Engineer with reasonable assistance which he may require at any time, to help in driving stakes or in laying out the work. He shall also furnish the Engineer with all required assistance to facilitate thorough inspection or culling over or removing of the work performed, or for any other purpose in the discharge of the Engineer's work and for which services no additional allowance will be made.

INCOMPETENT OR DISORDERLY PERSONS.

The Contractor shall dismiss from the work at any time, any superintendent, workmen or other persons employed by the Contractor who shall refuse or neglect to obey the instructions of the Engineer in anything relating to the work or who shall perform his work in any manner contrary the specifications or directions of the Engineer.

UNFAVORABLE CONDITIONS

When in the ópinoin of the Engineer the weather may be such that it is deemed advisable to discontinue the work,the Contractor shall cease operations according to the instructions of the Engineer and shall not assume operations until notified by the Engineer to do so.If in the opinoin of the Engineer the work and operations are not being carried according to ~~plans~~ contract and these plans and specifiications,he may order all work stopped immediately,and all work and operations carried on after such "Stop Order" will be subject to removal.

MATERIALS

All materials furnished shall be of the best quality of the respective kinds named in the contract and all materials used are subject to examination and approval by the Engineer with power to reject.

PROTECTION TO PROPERTY

Materials delivered to the work shall be neatly,safely and compactly placed in such manner as to cause the least inconvenience and damage to the property owners and the general public and not be within fifteen (15) feet of any fire hydrant.Injury to lawns,shade trees, sidewalks,streets and other improvements must be may good by the Contractor.

EXTRAS

No extras of any kind will be allowed on this work.

FOREMEN

The Contractor shall at all times have some competent foreman or authorized superintendent on thw work to whom notices,ordered and instruction s may be given.

DEBRIS

On completion of the work the Contractor must remove from the line of work and premises all surplus materials and all debris of every kind and description and he must restore to their former condition all sidewalks,crosswalks,tree plots, streets,pavements,curbs,fences and any other public and private property which may have become disturbed or damaged by reason of his work.

CONSTRUCTION AND OLD MATERIALS

The Contractor will be required to remove at his own expense any and all obstructions,filth or refuse of any kind that may be encountered in the line of his work and which may be required to be taken out in order to construct the new work;also any rubbish,refuse or materials produced by such work.

INDEMNITY

The Contractor shall keep and hold the "Owner" free and harmless from the payment of an y and all damages,expenses,royalties,patent fees,and any sum of money whatever,by reasons of the work and operations.

ASSIGNMENT CONTRACT

The Contractor shall not assign or transfer the contract or any part thereof except upon approval of the Owner.

****

EARTH EXCAVATION

Earth,clay,rock or whatever materials may be enco untered shall be excavated to such depth and demensions as will accomodate the work as shown upon the plans.Whatever filling is necessary to support any part of the structure shall be done in such manner that no settlement can possibly occur,by especially compacting the filling materials or by such manner or other means deemed necessary by the Engineer at the time the work is done.

The Contractor shall make provisions for properly handling all water en countered in the excavation.

The excavation shall include the loosening,loading,and disposing of all materials,wet or dry,necessary to be removed for the purpose of the construction.

Excavtion materials in excess of that n eeded for backfilling to within twelve (12) inches of the top of the wall and the regrading of the alley,shall be disposed of by the Contractor and must re removed from the site.

Space excavated without authority beneath all structures,shall be refilled with concrete by the Co ntractor at his own expense.

BACKFILLING

All lumber,rubbish and braces shall be carefully removed from behind the walls unless orderdd left in place by the Engineer.Unless otherwise specified all trenches or excavation shall then be backfilled to such grade that will conform with the regarding of the alley east of the wall.Backfilling shall be done as completely as possible in such a manner as to prevent after settlement. The time alapsed before back-filling begins shall be subject to the approval of the Engineer.

CONCRETE

Concrete shall consist of a mixture of cement,fine and course aggregate and water as hereinafter specified.

Proportion s

Concrete shall be proportioned as follows: 1 sack cemen t
2 cubic feet sand
3 ½ cubic feet course aggreg.

If plant mix is used it shall be 3500 pound concrete.

All aggregate shall be subject to the approval of the Engineer.Course aggregate shall be either crushed stone or gravel well graded between the limits of one quarter (¼) and one and one quarter (1¼) inch with the diameterical axis as nearly as possible th e same length,with all dust and other particles less than one quarter(¼) inch removed.Fine aggregate shall consist of clean sharp sand free from clay,loam,silt or vegetable matters and must pass the 24 hour Colorimetric Test.No concrete mix aggregate will be allowed on this work.

WATER

Water for mortar an d concrete shall be free from oil,acid,strong alkalis or evgetable matter.It will be supplied by and at the expense of the Contractor.

MIXING

Concrete shall be machine mixed.The concrete mixer shall be designed to take one complete batch of material (using whole bags of cement)and to mix that batch thoroughly before any portion of it is withdrawn or any portion of the succeeding batch is introduced.The mixer shall be equipped with a loading skip and a tank so design ed that when once set it will automatically supply to the mixer the amount of water so determined.

The aggregate for each batch shall be measured by means of cubic box markings on the wheel barrows and each batch shall be mixed at least one minute after all ingredients including water, have been discharged into the mixer.The speed of the mixer drum shall be approxiamtely 19 tevoltions per minute.The water content of the mix will be determin ed by the Engineer.

TRANPORTATION AND PLACING CONCRETE

After mixing the concrete shall be transported rapidly to the place of deposit. It shall be carried up level along the whole length of the section under construction,and shall be so placed as to avoid rehandling within the forms.It shall be spaded,rammed or vibrated into place and shall be thoroughly compacted around drain pipes or other shapes built into the work.
No concrete shall be placed in water.

JOINTS

X

Joints will be placed as directed by the Engineer.All joints shall be water tight.

SECTIONS

The Contractor shall so plan his work,so as to placed this work in sections and upon starting to placed concrete in a section he must continued placing concrete in that section until the same is completed,and in no case must concreted set more than thirty (30) minuted before additional concrete is placed on the same.

CONCRETE SURFACES

X

The concrete shall have a semi-smooth surface.Special care shall be taken to place the concrete solidly against the forms so as to leave no voids,that all concrete is solid,compact and water tight,and that all surfaces are smooth and free from all indentations and projections.All surfaces shall be free from voids, exposed stones,or other imperfections.If such imperfections are found upon removeing the forms,such faults,if minor,shall be corrected at the Contractor's expen se by filling with mortar or as otherwise directed.

No plastering of any co norete surface shall be done unless expressly permitted by the Engin eer,and if so permitted,shall be done in strict accordance with the direction of the Engineer.No payment will be made for plastering done to correct a defective work.
If the surface of the concrete is bulged,uneven,or shows honeycombing or form marks which in the opinoin cannot be repaired satisfactorily,the entire section shall be remo ved and replaced under the direction of the Engineer,and at the expense of the Contractor.

WATER TIGHTNESS
The Contractor is required to make the entire structure water tight.All cracks and imperfections developing at any point in the work shall be thoroughly repaired in a manner satisfactory to the Engineer.

Concrete shall be made with a minimum amount o f water consistent with proper workability.Said water content will be determined by the Engineer.Concrete shall be placed in a position that will prevent segregation or the formation of voids.

WAT ER PROOFING
The back of the retaining wall in contact with earth shall be water proofed with tar pitch or asphalt and applied to a thickness of one-eight (1/8") inch when the surface of the concrete is clean and perfectly dry.

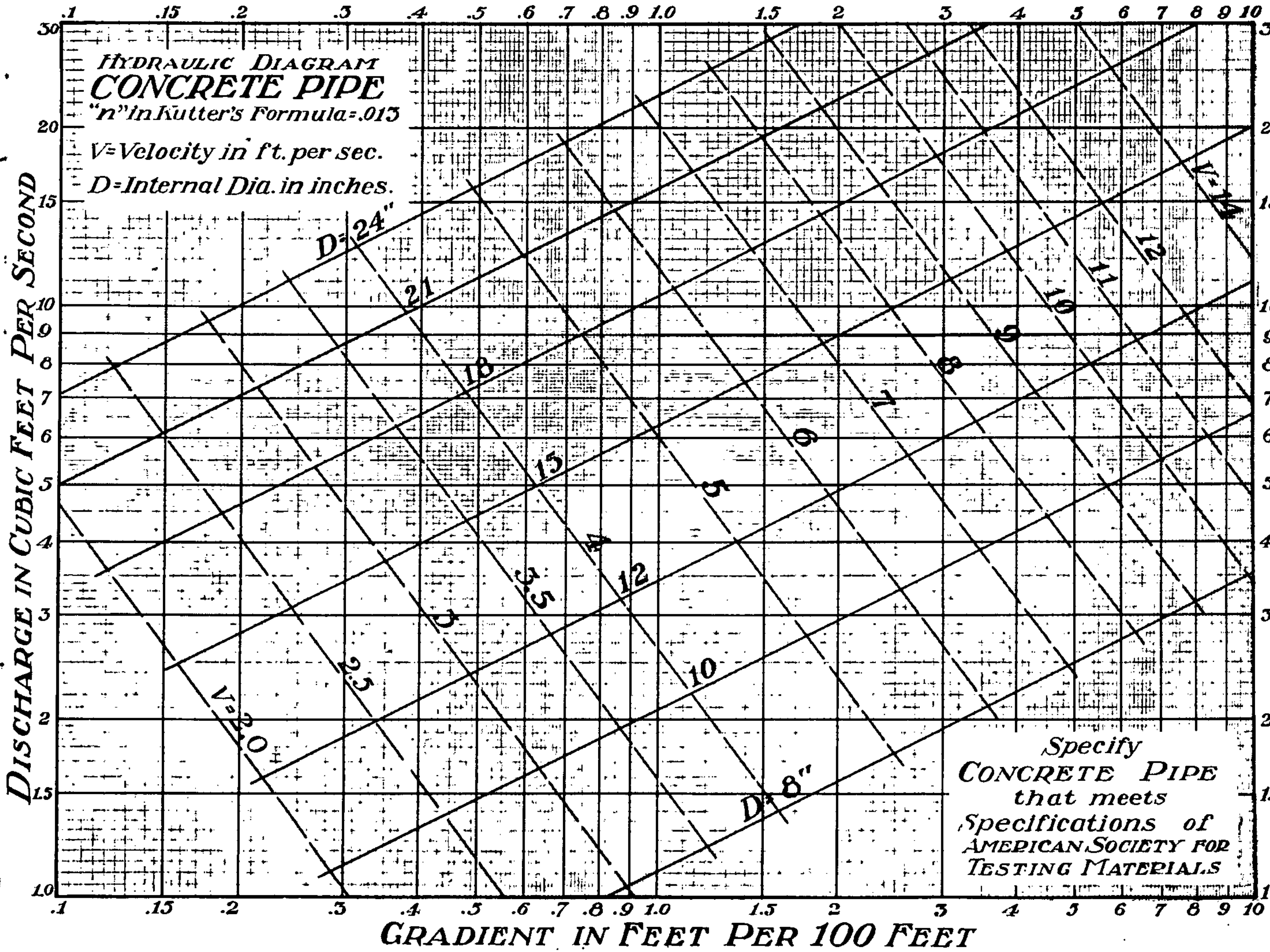
CURING
All exposed surfaces of concrete shall be protected from premature drying by being covered with burlap which shall be kept constantly moist by sprinkling with water.The damp burlap shall be placed as soon as the concrete is hard enough n ot to be marred by the process and sprinkling must be continue for a period of n ot less than seven (7) days and in case the the Engineer requires it,for a longer period of time.As an alternate to this proess a curing compound may be used,the brahd,subject to the approval of the Engineer.
No new work shall be laid during a rainstorm,freshly laid concrete shall be protected by canvas during storms to prevent the water from coming in contact with it.

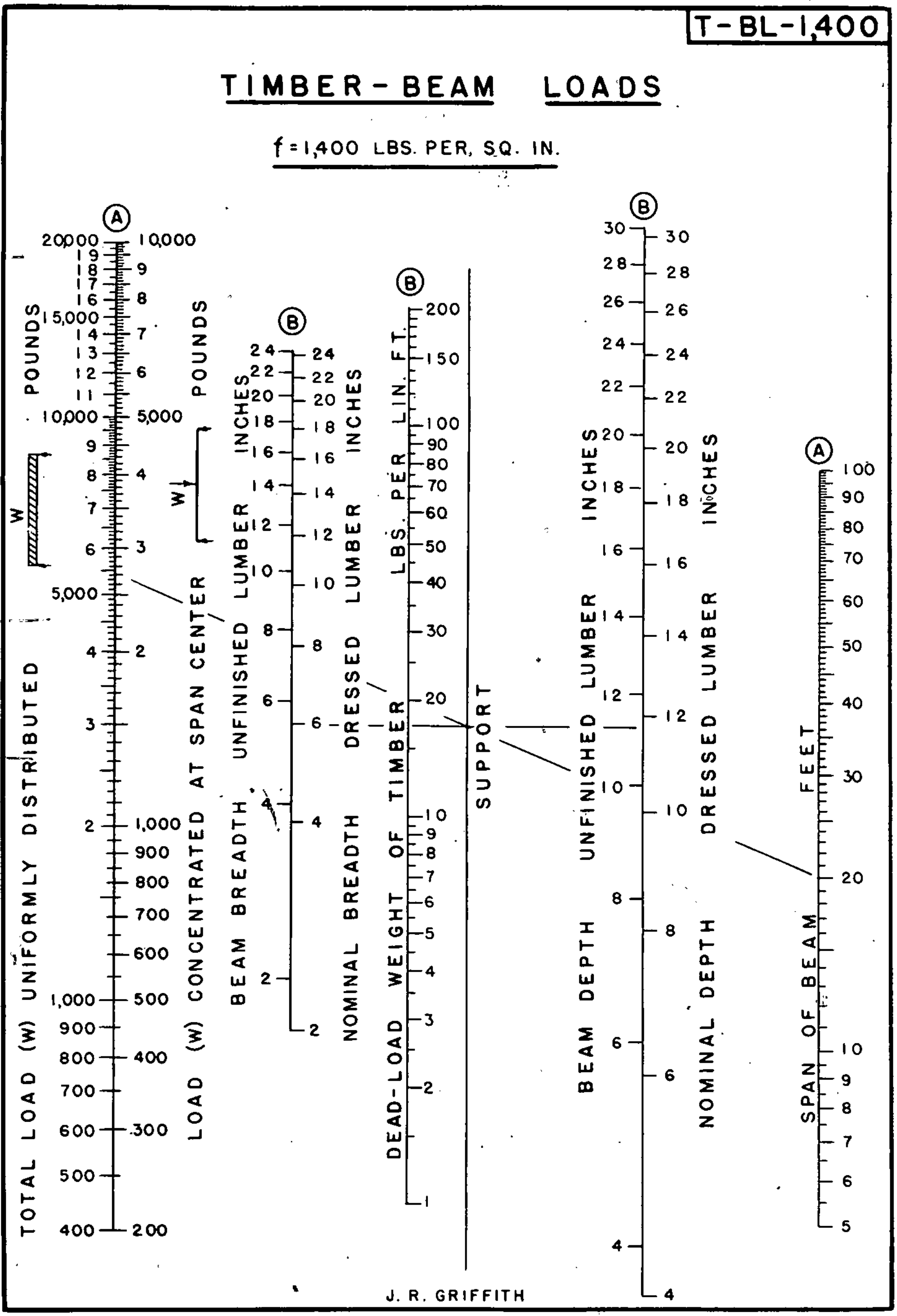
FORMS

The Contractor shall provide suitable water tight forms with smooth surfaces of ample strength an d rigidly braced.The form shall conform to the shape,lines and dimen sions of the concrete as called for on the plans.The bracing shall be entirely adequate to prevent deviations from the correct line.No forms shall be used which are not clean and of proper shape and strength and in every way suitable.Deformed,broken or defective forms shall be removed from the work.
Before placing concrete,the forms shall be coated with form grease,or oth er suitable substance approved by the Engineer,to prevent adherence of concrete.All forms and form lumber once used shall be thoroughly cleaned and recoated before being used again.All corn ers of finished concrete (at bulkheads)shall be chamfored.
All wooden forms shall be built of clean sound lumber,reasonably free from knots, dressed on one side and neatly fit.~~Tongue and~~ grooved or lock joint ship lap materials shall be used on all exposed surface faces of the wall covered by these specifications.All form surfaces shall be watertight,securely fastened by nails,or form pins,screws or bolts to the rib or support.~~[illegible]~~.

REMOVING FORMS
Forms shall not be disturbed until authorized by the Engineer.

DRAINAGE AND WEEP HOLE
Drainage or weep hole shall be constructed in the manner and at the points indicated upon the plans.
Over the upper eand of all weep holes shall be place a sufficient quanity of clean crushed stone(not less than one inch nor more than three inch size).
Provision shall likewise be made for keeping the stone from falling into the pipe.


HYDRAULIC DIAGRAM
CONCRETE PIPE
"n" in Kutter's Formula = .013
V = Velocity in ft. per sec.
D = Internal Dia. in inches.
D = 24"
21
18
15
12
10
D = 8"
V = 2.0
2.5
3
3.5
4
5
6
7
8
9
10
11
12
V = 14
Specify
CONCRETE PIPE
that meets
Specifications of
AMERICAN SOCIETY FOR
TESTING MATERIALS
DISCHARGE IN CUBIC FEET PER SECOND
GRADIENT IN FEET PER 100 FEET


T-BL-1,400
TIMBER-BEAM LOADS
f = 1,400 LBS. PER SQ. IN.
TOTAL LOAD (W) UNIFORMLY DISTRIBUTED POUNDS
LOAD (W) CONCENTRATED AT SPAN CENTER POUNDS
W
BEAM BREADTH UNFINISHED LUMBER INCHES
NOMINAL BREADTH DRESSED LUMBER INCHES
DEAD-LOAD WEIGHT OF TIMBER LBS. PER LIN. FT.
SUPPORT
BEAM DEPTH UNFINISHED LUMBER INCHES
NOMINAL DEPTH DRESSED LUMBER INCHES
SPAN OF BEAM FEET
A
B
J. R. GRIFFITH

The Building Official and the F. H. A.

By DAVID J. WITMER*
Chief Architectural Supervisor
Southern California District
Federal Housing Administration

BUILDING officials and the Federal Housing Administration are committed to upholding adequate building standards. Both are interested in improving housing standards and they seek, in their respective fields of service, to encourage further improvements in housing standards. In this they can be and are being mutually cooperative.

The city building inspector is a law enforcing officer. He can require compliance with the law or stop the work. The Federal Housing Administration is not vested with authority to stop work which does not comply with city or state laws, or FHA housing standards. It can and does, however, refuse to accept for insured loans, those properties which fail to comply. Because of this fact it has, and may grasp more firmly, the opportunity to set standards of housing somewhat higher than the minimum acceptable for building laws.

One of the main objectives of the National Housing Act is the improvement in housing standards and conditions. The Act is entitled, "An Act to encourage improvement in Housing Standards and Conditions, to provide a system of Mutual Mortgage Insurance, and for other purposes." Title I provides an expansion of credit for the purpose of modernizing, repairing and improving existing buildings, and leaves the determination of the nature and quality of the improvement to the borrower.

Title II authorizes a system of Mutual Mortgage Insurance and thereby an expansion of credit for financing the acquisition and construction of residential properties. The only reference to Housing Standards in Title II is complete and inclusive. Title II stipulates that each project covered by a mortgage accepted for insurance must be economically sound. The Act authorizes and directs the administrator of the Act to make such rules and regulations as may be necessary.

Stability and durability of structure are fundamentals of economic soundness, as are healthful and sanitary living conditions. Livability, desirability and appeal of residential properties are as fundamental to economic soundness and as necessary in the improvement of housing standards as structural and health provisions are to a building code. The maintenance and security of a property for residential purposes, and the protection of the neighborhood in which such property is located as a desirable residential community, are essential to economic soundness.

Recognition by cities and counties, of the necessity of protecting residential neighborhoods for residential purposes, is becoming more and more manifest through the establishment of zoning and setback ordinances. Recognition of other fundamentals of economic soundness and social security and welfare, over and above the sole considerations of structural safety and health, are bound to come and will be increasingly evident.

At present the Federal Housing Administration, under authority of the National Housing Act, is the one agency which is testing and considering all the phases of economic soundness pertinent to residential properties.

In order to consider intelligently and measure with reasonable accuracy the economic soundness of residential properties, and the fundamentals composing economic soundness, it was necessary to set up a definition of these fundamentals and then a practicable measure or minimum standard for each fundamental. The Federal Housing Administration accomplished this in Circular No. 2, Property Standards.

Some of these standards are set forth very definitely. Others are left to the interpretation and application of the District Office of the Federal Housing Administration in conformity

(Continued on Page 20)

* Presented before the 13th Annual Meeting of the Pacific Coast Building Officials Conference, Pasadena, Calif., October 8-12, 1935.

SHIPPING DATA
(PAGE 4)

(Summary of Data Received at Press Time)

Make and Model	Weight (Lbs.)	Width	Length	Height
C106	10,050	9'4"	24'4"	6'5"
C108	14,700	10'4"	27'4"	7'8"
C114	19,730	11'5"	30'7"	8'5"
TS300	42,500	11'6¾"	34'10½"	9'4"
LaPlant-Choate (Railway Shipping)				
C22	3,050	5'11"	12'0"	3'11"
C24	3,000	5'11"	16'0"	3'11"
C-42	7,100	7'8¾"	17'1½"	5'8¼"
C44	7,200	7'8¾"	22'7"	5'8¼"
C106	10,550	9'4"	24'4"	6'5"
C108	15,200	10'4"	27'4"	7'8"
C114	20,230	11'5"	30'7"	8'5"
TS300	43,500	11'6¾"	34'10½"	9'4"
Le Tourneau (Highway or Railway Shipping)				
B Tournapull	44,500	11'7"	37'6"	11'3"
C Tournapull	29,220	11'4"	31'0"	9'3"
Super C Tournapull	32,500	10'2"	32'2"	11'2"
Model D	7,000	7'2"	21'0"	7'6"
Model M	11,000	8'1"	23'4"	8'7"
Model LS	13,750	9'10"	29'7"	9'11"
Model LP	19,700	10'2"	32'2"	10'11"
Model FP	22,000	11'6¾"	34'7"	10'9"
Model W	34,580	11'6"	39'0"	11'10"
Wooldridge (Highway or Railway Shipping)				
TC-S14	45,200(43)	11'5⅛"	34'7½"	10'1⅜"
BBM	10,800(43)	8'3½"	23'3¼"(44)	8'0"
BB-85	15,800(43)	9'9¾"	29'8"(44)	9'10"
BBU	17,900(43)	9'9"	30'8("44)	9'0"
TCR	24,100(43)	11'5½"	32'6"(44)	10'0"
TCN	26,000(43)	11'5½"	33'4⅜"(44)	10'5"
TCH	32,000(43)	11'6½"	35'3"(44)	10'11"

TRACTORS WITH BULLDOZER ATTACHED

Make and Model	Weight (Lbs.)	Width	Length	Height
Baker (Highway or Railway Shipping)				
19B	47,600	11'1"	19'6"	7'3 13/16"
424A	17,815	8'5"	12'6½"	7'10½"
Caterpillar (Highway Shipping)				
D4-44" and 4S	13,165	7'3"	12'0"	5'1"
D4-44" and 4A	13,865	7'3"	14'2"	5'1"
D2-40" and 2S	8,740	5'8"	10'1"	4'10"
D2-50" and 2S	8,980	6'8"	10'1"	4'10"
D2-40" and 2A	9,660	6'1"	12'1"	4'10"
D2-50" and 2A	9,920	7'9"	12'5"	4'10"
Caterpillar (Railway Shipping)				
D8 and 8S	40,910	10'8"	27'0"	7'6"
D8 and 8A	41,860	10'8"	27'0"	7'6"
D7 and 7S	30,280	10'4"	21'0"	6'8"
D7 and 7A	31,480	10'4"	27'0"	6'8"
D6-60" and 6S	20,725	8'3"	17'0"	6'4"
D6-60" and 6A	21,150	9'6"	18'0"	6'4"
D6-74" and 6S	21,495	9'6"	18'0"	6'4"
D6-74" and 6A (45)	21,790	8'3"	27'0"	6'4"
D4-44" and 4S	13,165	7'3"	12'0"	5'1"
D4-60" and 4S	13,500	8'3"	12'0"	5'1"
D4-44" and 4A	13,865	7'3"	14'2"	5'1"
D4-60" and 4A	14,200	8'8"	14'6"	5'1"
D2-40" and 2S	8,740	5'8"	10'1"	4'10"
D2-50" and 2S	8,980	6'8"	10'1"	4'10"
D2-40" and 2A	9,660	6'1"	12'1"	4'10"
D2-50" and 2A	9,920	7'9"	12'5"	4'10"
Heil (Highway or Railway Shipping)				
CE-18-BW	28,070	10'0"	16'0"	6'7"
HB-14W	20,175	9'6"	14'11"	6'1¾"
HB-60	16,506	7'6"	13'0"	5'5"
HB-95	36,110	10'¾"	16'3"	7'4"
Isaacson (Highway or Railway Shipping)				
HD7	18,920	7'4"	12'7"	5'6 9/16"
D8	42,200	11'2"	19'2"	9'3½"
D6	21,855	7'11¾"	15'0"	6'3¼"
FD	36,520	9'8"	16'7½"	9'3"
DG, DGH	17,140	6'9"	13'10"	5'5"
TD18	30,420	8'6"	16'7"	9'4"
TD14	21,475	8'0"	13'9"	6'1¾"
Wooldridge (Highway or Railway Shipping)				
BD8	39,160(43)	10'6"	17'1⅛"(43)	9'5½"
BD7	29,130(43)	10'1¾"	16'2½"(43)	8'7¾"
BD-6W	21,030(43)	9'6"	14'11¼"(43)	8'1¼"
BHD-19	47,000(43)	11'5¾"	18'3¾"(43)	8'3¾"
BHD-14	33,660(43)	8'7¾"	15'3½"(43)	9'6"
BHD-10W	25,710(43)	8'9¾"	14'4"(43)	9'1"
BHD-7W	17,010(43)	8'4½"	12'7⅜"(43)	7'6"
BTD-18W	27,250(43)	10'1¾"	14'9¾"(43)	8'4½"
BTD-14W	19,800(43)	9'5¾"	12'11⅞"(43)	8'2¾"

Shipping Data Notes

(1) Loaded in units on cars or trucks.
(2) 20 tons/hour.
(3) Adjustable. Set to maximum width.
(4) Vibratory hand screed.
(5) Specified width plus 1'0".
(6) Does not include feed and delivery conveyors which weigh 4,800 lbs.
(7) Does not include power unit.
(8) Railway shipping data vary too much to specify.
(9) Height without cab—8'0".
(10) Height without cab—7'8".
(11) Height without cab—7'6½".
(12) Height without cab—7'6".
(13) Height without cab—7'3½".
(14) Height without cab—8'8".
(15) Add 675 lbs. for machine equipped with diesel engine.
(16) Add 250 lbs. for leaning front wheels. Add 620 lbs. for scarifier.
(17) Height to top of vertical exhaust pipe.
(18) Height without cab.
(19) Add 200 lbs. for machine equipped with diesel engine.
(20) Boom length—15'0".
(21) Boom length—16'3½".
(22) Boom length—16'10".
(23) Boom length—30'0".
(24) 18" shoes.
(25) 30' boom not assembled.
(26) Bucket not included.
(27) Without front end attachments.
(28) 24" shoes.
(29) 16" shoes.
(30) 21" shoes.
(31) 30" shoes.
(32) 28" shoes.
(33) Increase 2,000 lbs. for diesel engine. Increase 2,000 lbs. for 33" shoes.
(34) 11'9" for 33" shoes.
(35) Angle of boom with horizontal—40°.
(36) For 20" shoes overall width is 8'2".
(37) Add 230 lbs. for machine equipped with diesel engine.
(38) Add 165 lbs. for machine equipped with diesel engine.
(39) Add 510 lbs. for machine equipped with UD-9 diesel engine; add 825 lbs. for UD-14 diesel engine.
(40) With 16" drive roll.
(41) Dual rear wheels.
(42) Single rear wheels.
(43) Without power control unit.
(44) Length can be reduced 20% by removing the front truck and hitch.
(45) Blade not attached.
. . . Information not available Feb. 1, 1948.

SURFACE AREAS OF VARIOUS WIDTHS OF ROADWAY PER 100 FEET AND PER MILE

Especially Prepared for Powers' Road and Street Catalog

Width, Feet	Area Sq. Yds. Per 100 Ft.	Area Sq. Yds. Per Mile	Width, Feet	Area Sq. Yds. Per 100 Ft.	Area Sq. Yds. Per Mile
8	89	4,693	28	311	16,427
9	100	5,280	30	333	17,600
10	111	5,867	32	356	18,773
11	122	6,453	33	367	19,360
12	133	7,040	36	400	21,120
14	156	8,213	40	444	23,467
16	178	9,387	44	489	25,813
18	200	10,560	45	500	26,400
20	222	11,733	48	533	28,160
22	244	12,907	50	556	29,333
24	267	14,080	54	600	31,680
26	289	15,253	55	611	32,267
27	300	15,840	60	667	35,200

SOIL AND GRADING DATA

Shrinkage and Settlement
Allowable Soil Pressures
Slopes and Angles of Repose
Weights of Materials

From a Bucyrus-Erie Booklet—"Profit"

The expansion due to excavation is usually 15 to 20% of the volume, but in extreme cases may be as much as 40%. In placing the material in the embankment it is compressed by the weight of the embankment itself or by the action of wheels and treads, when haulage equipment is employed. The loss of porosity and losses in transportation reduce the original volume in time.

APPROXIMATE SHRINKAGE PERCENTAGES

Gravel	8%
Gravel and Sand	9%
Clay and Clayey Earth	10%
Loam and Light Sandy Earth	12%
Loose Vegetable Surface Soil	15%

ALLOWABLE SOIL PRESSURES

	Tons Per Sq. Ft. Min.	Tons Per Sq. Ft. Max.	Lbs. Per Sq. In. Max.
Quicksand; Alluvial Soil	0.5	1	13.9
Soft Clay	[illegible]	2	26.9
Wet Clay; Soft Wet Sand	1	2	26.9
Moderately Dry Sand	2	3	41.7
Clay and Sand in Alternate Layers	2	3	41.7
Firm & Dry Loam or Clay	2	5	69.5
Compact Coarse Sand	3	6	83.5
Coarse Gravel	5	8	110.1
Gravel and Sand Well Cemented	6	10	139.0
Good Hard Pan or Shale	6	10	139.0
Hard Native Bedrock	15	25	348.0

SLOPES AND ANGLES OF REPOSE OF LOOSE EARTH

Kind of Earth	Slope of Repose	Angle of Repose
Sand	1.5 to 1	34°
Sand and Clay	1.33 to 1	37°
Clay, Dry	1.75 to 1	30°
Clay, Damp and Plastic	3 to 1	18°
Gravel	1.33 to 1	37°
Gravel and Clay	1.33 to 1	37°
Gravel, Sand and Clay	1.33 to 1	37°
Soil, Dry	1.5 to 1	34°
Soil, Wet	1.33 to 1	37°
Soft Rotten Rock	1.33 to 1	37°
Hard Rotten Rock	1 to 1	45°

WEIGHTS OF MATERIALS

Material	Lbs. Per Cu. Ft.	Lbs. Per Cu. Yd.	Kgs. Per Cu. Mtr.
Clay—			
Dry Excavated	90	2430	1440
Wet Excavated	110	2970	1760
Clay & Gravel, Dry	100	2700	1600
Coal—			
Anthrac., Broken	57	1540	915
Bitum., Broken	52	1400	830
Earth—			
Dry, Loose	76	2050	1217
Dry, Packed	95	2560	1520
Mud, Loose	108	2920	1730
Mud, Packed	115	3100	1840
Moist, Loose	78	2100	1245
Moist, Packed	96	2590	1535
Granite—			
Block	175	4720	2800
Broken	96	2590	1535
Gravel—			
Screen ¼" to 2"	90	2430	1440
Gypsum—			
Rock, Crushed	100	2700	1600
Iron Ore—			
Hermatite—			
In Bank	180	4850	2880
Loose	160	4320	2560
Magnetic	180	4850	2880
Limonite	135	3650	2165
Lime	64	1730	1025
Limestone—			
Block	165	4450	2640
Broken	95	2560	1520
Masonry—Debris	90	2480	1440
Sand—			
Dry	80	2160	1280
Damp	105	2840	1683
Wet	120	3240	1920
Sandstone—Broken	82	2220	1318
Shale—Broken	92	2480	1470
Snow—			
Freshly Fallen	8	216	128
Frozen Ice	56	1510	895
Trap Rock—			
Broken	107	2900	1720

COMPACTION OF LOOSE MATERIALS UNDER ROLLING

The compaction of stone or gravel under rolling varies greatly according to weight of roller, size and grading of the material, percentage of voids, and character of sub-grade. On one series of tests percentages of reduction in thickness were recorded as follows:

1½ in. to 3 in. limestone under 5.8 ton tandem roller.. 11%
1½ in. to 3 in. limestone under 3.3 ton tandem roller.. 2%
1 in. to 2 in. limestone under 5.8 ton tandem roller.. 14%
1 in. to 2 in. limestone under 3.3 ton tandem roller.. 8%

In some cases reductions of 30 per cent or more have been observed.

FILLER FOR CRUSHED STONE MACADAM BOTTOM COURSE

Approximate Amounts Required, Using 0.35 Cu. Yd. Filler Per Cu. Yd. of Rolled Base

Width Macadam Ft.	Rolled Depth of Bottom Course 3-In.	4-In.	5-In.	6-In.
	Cubic Yards Filler Per 100 Ft. of Road			
10	3.2	4.3	5.4	6.5
12	3.9	5.1	6.5	7.8
14	4.5	6.0	7.5	9.1
15	4.9	6.4	8.0	9.7
16	5.2	6.9	8.6	10.4
18	5.9	7.8	9.7	11.8
20	6.4	8.6	10.8	12.8
22	7.0	9.4	11.8	14.3

WASTE, LOSS AND OVERRUN OF CONCRETE

Where weighed or measured aggregates are delivered directly to the mixer there should be no waste or loss. Where there is intermediate storing or handling the losses commonly range from 2 per cent to 5 per cent.

Irregularities in subgrade surface require the placing of some concrete in addition to that included within the exact design limits of the slab. The overrun due to this cause ordinarily amounts to from 2 per cent to 4 per cent of the total concrete required, but on a poorly prepared subgrade may be as high as 8 per cent.

BROKEN STONE

Pounds Per Cubic Yard

From Bituminous Construction Handbook published by Barber-Greene Co., Aurora, Ill.

Kind	Sp. Gr.	Spread Loose 45% Voids	Compacted 30% Voids
Trap	2.8	2590	3300
	2.9	2680	3420
	3.0	2770	3540
	3.1	2870	3650
Granite	2.6	2400	3060
	2.7	2500	3180
	2.8	2590	3300
Limestone	2.6	2400	3060
	2.7	2500	3180
	2.8	2590	3300
Sandstone	2.4	2220	2830
	2.5	2310	2940
	2.6	2400	3060
	2.7	2500	3180

APPROXIMATE WEIGHTS OF AGGREGATE PER CUBIC YARD LOOSE MEASURE

The unit weight of any of the aggregates here listed will vary according to mineral composition, size and grading, such variation running roughly within a range of 20 per cent. A further substantial variation is due to moisture, which commonly amounts to between 5 and 10 per cent of the weight of the dry material, but may in the extreme case of completely soaked sand amount to 25 per cent. This table is for ordinary materials about midway in the weight range, in a thoroughly loose condition, and containing such moisture as is commonly found in commercial products.

	Pounds Per Cu. Yd.		Pounds Per Cu. Yd.
Slag	2,000	Crushed trap rock	2,600
Crushed limestone	2,400	Pea gravel	2,650
Crushed granite	2,400	Sand	2,800
Crushed gravel	2,550	Bank-run gravel	3,000

TONS OF STONE PER MILE REQUIRED FOR VARIOUS FINISHED DEPTHS AND WIDTHS

(Based on Stone Weighing 2,650 Pounds Per Cubic Yard)

From Report of Commissioner of Public Roads of New Jersey

Width, 8 Ft.		—9 Ft.—		—10 Ft.—		—11 Ft.—	
Depth	Tons	Depth	Tons	Depth	Tons	Depth	Tons
4	875	4	984	4	1,093	4	1,203
6	1,312	6	1,476	6	1,640	6	1,804
8	1,750	8	1,968	8	2,187	8	2,406
10	2,187	10	2,460	10	2,734	10	3,008
12	2,625	12	2,952	12	3,281	12	3,609

Width, 12 Ft.		—13 Ft.—		—14 Ft.—		—15 Ft.—	
Depth	Tons	Depth	Tons	Depth	Tons	Depth	Tons
4	1,312	4	1,421	4	1,531	4	1,640
6	1,969	6	2,132	6	2,296	6	2,460
8	2,625	8	2,843	8	3,062	8	3,281
10	3,281	10	3,554	10	3,828	10	4,101
12	3,937	12	4,265	12	4,593	12	4,921

Width, 16 Ft.		—17 Ft.—		—18 Ft.—		—19 Ft.—	
Depth	Tons	Depth	Tons	Depth	Tons	Depth	Tons
4	1,750	4	1,859	4	1,968	4	2,078
6	2,625	6	2,789	6	2,953	6	3,117
8	3,500	8	3,718	8	3,937	8	4,156
10	4,375	10	4,648	10	4,921	10	5,195
12	5,250	12	5,578	12	5,906	12	6,234

Width, 20 Ft.	
Depth	Tons
4	2,187
6	3,281
8	4,375
10	5,468
12	6,562

MORTAR SAND

The following is a common specification for sand.

Sand for mortar shall be uniformly graded from fine to coarse within the following limits:

	Per cent
Passing No. 8 sieve	100
Passing No. 50 sieve	15-40
Passing No. 100 sieve	0-10

(Weight removed by decantation not more than 5 per cent.)

QUANTITIES OF ROAD METAL OR AGGREGATE PER 100 FEET AND PER MILE FOR VARIOUS WIDTHS AND THICKNESSES

Loose Measure

	9 Feet Wide		10 Feet Wide		12 Feet Wide	
Thickness in inches	Cu. Yd. per 100 ft.	Cu. Yd. per mile	Cu. Yd. per 100 ft.	Cu. Yd. per mile	Cu. Yd. per 100 ft.	Cu. Yd. per mile
1	2.8	147	3.1	163	3.7	196
2	5.6	293	6.2	326	7.4	391
2½	6.9	367	7.7	407	9.3	489
3	8.3	440	9.3	489	11.1	586
4	11.1	587	12.3	652	14.8	782
5	13.9	733	15.4	814	18.5	978
6	16.7	880	18.5	977	22.2	1,173
7	19.4	1,027	21.6	1,140	25.9	1,369
8	22.2	1,173	24.7	1,303	29.6	1,564
9	25.0	1,320	27.8	1,466	33.3	1,760
10	27.8	1,467	30.9	1,630	37.0	1,956

	16 Feet Wide		18 Feet Wide		20 Feet Wide	
Thickness in inches	Cu. Yd. per 100 ft.	Cu. Yd. per mile	Cu. Yd. per 100 ft.	Cu. Yd. per mile	Cu. Yd. per 100 ft.	Cu. Yd. per mile
1	4.9	261	5.6	293	6.2	326
2	9.9	522	11.1	586	12.3	652
2½	12.3	652	13.9	733	15.4	815
3	14.8	782	16.7	880	18.5	978
4	19.7	1,043	22.2	1,173	24.7	1,304
5	24.7	1,304	27.8	1,466	30.9	1,630
6	29.6	1,564	33.3	1,759	37.0	1,956
7	34.6	1,825	38.9	2,053	43.2	2,281
8	39.5	2,086	44.4	2,346	49.4	2,607
9	44.4	2,347	50.0	2,639	55.6	2,933
10	49.3	2,607	55.5	2,932	61.7	3,259

	22 Feet Wide		24 Feet Wide		25 Feet Wide	
Thickness in inches	Cu. Yd. per 100 ft.	Cu. Yd. per mile	Cu. Yd. per 100 ft.	Cu. Yd. per mile	Cu. Yd. per 100 ft.	Cu. Yd. per mile
1	6.8	359	7.4	391	7.7	407
2	13.6	717	14.8	782	15.4	815
2½	17.0	896	18.5	978	19.3	1,019
3	20.4	1,076	22.2	1,173	23.1	1,222
4	27.2	1,434	29.6	1,564	30.9	1,630
5	34.0	1,793	37.0	1,956	38.6	2,037
6	40.7	2,151	44.4	2,347	46.3	2,444
7	47.5	2,510	51.8	2,738	54.0	2,860
8	54.3	2,868	59.3	3,129	61.7	3,259
9	61.1	3,227	66.6	3,520	69.4	3,667
10	67.9	3,585	74.1	3,911	77.1	4,074

	26 Feet Wide		30 Feet Wide		33 Feet Wide	
Thickness in inches	Cu. Yd. per 100 ft.	Cu. Yd. per mile	Cu. Yd. per 100 ft.	Cu. Yd. per mile	Cu. Yd. per 100 ft.	Cu. Yd. per mile
1	8.0	424	9.3	489	10.2	538
2	16.0	847	18.5	978	20.4	1,075
2½	20.1	1,059	23.1	1,222	25.5	1,344
3	24.1	1,271	27.8	1,466	30.5	1,613
4	32.1	1,695	37.0	1,956	40.7	2,150
5	40.1	2,119	46.3	2,444	50.9	2,688
6	48.1	2,542	55.6	2,933	61.1	3,225
7	56.2	2,983	64.8	3,422	71.3	3,765
8	64.2	3,390	74.1	3,911	81.4	4,300
9	72.2	3,813	83.3	4,400	91.6	4,838
10	80.2	4,237	92.6	4,889	101.8	5,376

APPROXIMATE QUANTITIES OF FREE WATER CARRIED BY AVERAGE AGGREGATES

Very wet sand	¾ to 1 gal. per cu. ft.
Moderately wet sand	½ gal. per cu. ft.
Moist sand	¼ gal. per cu. ft.
Moist gravel or crushed rock	¼ gal. per cu. ft.

The coarser the aggregate, the less free water it will carry.

TONS OF AGGREGATE PER MILE REQUIRED TO BUILD WATER-BOUND MACADAM

Table prepared by The Barrett Company, 40 Rector St., New York, N. Y.

Width, Ft.	Weight of Aggregate pounds per Cu. Yd.	Tons of Aggregate — 4-in. Depth — Coarse	Filler	6-in. Depth — Coarse	Filler	8-in. Depth — Coarse	Filler	10 in. Depth — Coarse	Filler
8	2,000	648	216	874	324	1,296	432	1,620	540
	2,400	778	260	1,166	387	1,555	520	1,847	648
	2,600	842	281	1,265	421	1,685	562	2,110	704
9	2,000	730	243	1,100	365	1,455	487	1,820	608
	2,400	875	292	1,310	437	1,750	584	2,185	730
	2,600	947	316	1,420	475	1,792	632	2,370	790
10	2,000	810	269	1,215	405	1,620	540	2,020	672
	2,400	970	323	1,458	485	1,840	648	2,430	810
	2,600	1,053	350	1,580	525	2,180	700	2,630	875
11	2,000	890	297	1,336	445	1,810	596	2,220	740
	2,400	1,070	356	1,610	534	2,140	712	2,670	890
	2,600	1,148	384	1,740	576	2,340	770	2,885	960
14	2,000	1,135	377	1,660	566	2,270	756	2,830	944
	2,400	1,360	453	2,040	680	2,720	906	3,400	1,134
	2,600	1,470	489	2,200	734	2,930	980	3,670	1,225

CUBIC YARDS OF LOOSE GRAVEL REQUIRED TO MAKE ONE MILE OF ROAD OF VARIOUS THICKNESSES AFTER CONSOLIDATION

From a Report of the Commissioner of Public Works of New Jersey

Width	Thickness of Road After Consolidation, Inches						
	6	7	8	9	10	11	12
Feet							
6	880	1,027	1,173	1,320	1,467	1,613	1,760
7	1,027	1,198	1,369	1,540	1,711	1,882	2,054
8	1,173	1,369	1,564	1,760	1,956	2,151	2,346
9	1,320	1,540	1,760	1,980	2,200	2,420	2,640
10	1,467	1,711	1,956	2,200	2,444	2,689	2,934
11	1,613	1,882	2,151	2,420	2,689	2,958	3,226
12	1,760	2,053	2,346	2,640	2,933	3,227	3,520
13	1,907	2,224	2,542	2,860	3,178	3,496	3,814
14	2,054	2,396	2,738	3,080	3,422	3,764	4,107
15	2,200	2,567	2,933	3,300	3,667	4,033	4,400
16	2,346	2,738	3,128	3,520	3,912	4,302	4,692
17	2,493	2,909	3,324	3,740	4,156	4,571	4,986
18	2,640	3,080	3,520	3,960	4,400	1,840	5,280
19	2,787	3,250	3,716	4,180	4,644	5,109	5,574
20	2,933	3,422	3,911	4,400	4,888	5,378	5,866

ENGINEERING CONSTANTS

MISCELLANEOUS

1.8° Fahrenheit = 1° Centigrade.
14.696 Pounds per Square Inch = atmospheric pressure.
13.144 Cubic Feet = volume 1 lb. air at 62° F. and 14.7 pounds per square inch.
1,728 Cubic Inches = 1 cubic foot.
5,280 Feet = 1 mile.
Doubling the diameter of pipe or hose increases its capacity approximately four times.
Diameter of Circle: Multiply circumference by 0.31831.
Circumference of Circle: Multiply diameter by 3.1416.
Area of Circle: Multiply square of diameter by 0.7854.

POWER.

1 HP = 33,000 foot pounds per minute.
1 HP = 746 watts.
1 HP = 2,543 B. T. U. per hour.
1 Kw.-Hr. = 3,415 B. T. U.
1 Kw. = 1.341 HP.

WATER

1 U. S. Gallon = 231 cubic inches.
1 U. S. Gallon = 8⅓ pounds at 62° F.
1 Cubic Foot = 7.48 U. S. gallons.
1 Cubic Foot = 62.5 pounds at 62° F.
2,309 Feet Water = 1 pound per square inch.
1 British Imperial Gallon = 1.2003 U. S. gallons.

Sand for Bituminous Mixtures

The following is a common specification for sand. When tested by means of laboratory sieves the sand shall conform to the following requirements:

	Per Cent
Total passing No. 4 sieve........	100
Total passing No. 10 sieve........................	95–100
Passing No. 10 sieve, retained on No. 40 sieve......	18– 50
Passing No. 40 sieve, retained on No. 80 sieve......	30– 60
Passing No. 80 sieve, retained on No. 200 sieve....	15*– 40
Total passing No. 200 sieve......................	0–5

*For bituminous concrete, the minimum required shall be 12 per cent.

SETTLEMENT OF AGGREGATE DUE TO HAULING

Size of Stone	Settlement After a Haul of ½ Mile or More in Wagons	75 Miles or More in Cars
⅜-in. screenings	12.1%	....
¼-in. screenings	11.8%	10.6%
2 to ¾-in.	9.2%	.....
3 to 2-in.	8.2%	7.0%

COSTS PER MILE OF ROAD AT VARIOUS PRICES PER SQUARE YARD

From a Report of the Commissioner of Public Roads of New Jersey

Width	Total Area Sq. Yds.	Price in Cents Per Sq. Yd. 25	30	35	40	45	50
8	4,693	$1,173	$1,408	$1,642	$1,877	$2,112	$2,346
10	5,867	1,466	1,760	2,053	2,346	2,640	2,933
12	7,040	1,760	2,112	2,464	2,816	3,168	3,520
14	8,213	2,053	2,464	2,874	3,285	3,696	4,106
16	9,386	2,346	2,816	3,285	3,754	4,224	4,693
18	10,560	2,640	3,168	3,696	4,224	4,752	5,280

Width	Total Area Sq. Yds.	Price in Cents Per Sq. Yd. 55	60	65	70	75	80
8	4,693	$2,581	$2,816	$3,050	$3,285	$3,520	$3,754
10	5,867	3,227	3,520	3,813	4,107	4,400	4,693
12	7,040	3,872	4,224	4,576	4,928	5,280	5,632
14	8,213	4,517	4,928	5,338	5,749	6,160	6,570
16	9,386	5,162	5,632	6,101	6,570	7,040	7,509
18	10,560	5,808	6,336	6,864	7,392	7,920	8,448

Width	Total Area Sq. Yds.	Price in Cents Per Sq. Yds. 85	90	95	100
8	4,693	$3,989	$4,224	$4,458	$4,693
10	5,867	4,987	5,280	5,573	5,867
12	7,040	5,984	6,336	6,688	7,040
14	8,213	6,981	7,392	7,802	8,213
16	9,386	7,978	8,448	8,917	9,386
18	10,560	8,976	9,504	10,032	10,560

DISTANCE IN LINEAR FEET WHICH A GIVEN TRUCK LOAD OF AGGREGATE WILL SPREAD FOR VARIOUS LOOSE DEPTHS ON VARIOUS WIDTHS OF ROAD

From Koppers Tarmac Handbook, published by Tar and Chemical Division, Koppers Company, Pittsburgh, Pa.

Width of Road. Feet	Loose Depth Spread. Inches	CUBIC YARDS PER LOAD 1	1½	2	2½	3	3½	4	5
		Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet
6	1	54.0	81.0	108.0	135.0	162.0	189.0	216.0	270.0
	2	27.0	40.5	54.0	67.5	81.0	94.5	108.0	135.0
	3	18.0	27.0	36.0	45.0	54.0	63.0	72.0	90.0
	4	13.5	20.3	27.0	33.8	40.5	47.3	54.0	67.5
	5	10.8	16.2	21.6	27.0	32.4	37.8	43.2	54.0
	6	9.0	13.5	18.0	22.5	27.0	31.5	36.0	45.0
8	1	40.5	60.8	81.0	101.3	121.5	141.8	162.0	202.5
	2	20.3	30.4	40.5	50.6	60.8	70.9	81.0	101.3
	3	13.5	20.3	27.0	33.8	40.5	47.3	54.0	67.5
	4	10.1	15.2	20.3	25.3	30.4	35.4	40.5	50.6
	5	8.1	12.1	16.2	20.3	24.3	28.4	32.4	40.5
	6	6.8	10.1	13.5	16.9	20.3	23.6	27.0	33.8
9	1	36.0	54.0	72.0	90.0	108.0	126.0	144.0	180.0
	2	18.0	27.0	36.0	45.0	54.0	63.0	72.0	90.0
	3	12.0	18.0	24.0	30.0	36.0	42.0	48.0	60.0
	4	9.0	13.5	18.0	22.5	27.0	31.5	36.0	45.0
	5	7.2	10.8	14.4	18.0	21.6	25.2	28.8	36.0
	6	6.0	9.0	12.0	15.0	18.0	21.0	24.0	30.0
10	1	32.4	48.6	64.8	81.0	97.2	113.4	129.6	162.0
	2	16.2	24.3	32.4	40.5	48.6	56.7	64.8	81.0
	3	10.8	16.2	21.6	27.0	32.4	37.8	43.2	54.0
	4	8.1	12.2	16.2	20.3	24.3	28.4	32.4	40.5
	5	6.5	9.7	13.0	16.2	19.4	22.7	25.9	32.4
	6	5.4	8.1	10.8	13.5	16.2	18.9	21.6	27.0

U. S. STANDARD SIEVE SERIES

Standard Specifications of the U. S. Bureau of Standards and the American Society for Testing Materials

Bureau of Standards Sieve Number	Specified Sieve Opening English Inch	Specified Sieve Opening Milli-meters	Specified Wire Diameter English Inch	Specified Wire Diameter Milli-meters	Average Opening	Tolerances Permitted Wire Diameter	Tolerances Permitted Maximum Opening
# 4	.187	4.76	.050	1.27	+—3%	—15% to +30%	10%
# 5	.157	4.00	.044	1.12	+—3%	—15% to +30%	10%
# 6	.132	3.36	.040	1.02	+—3%	—15% to +30%	10%
# 7	.111	2.83	.036	.92	+—3%	—15% to +30%	10%
# 8	.0937	2.38	.0331	.84	+—3%	—15% to +30%	10%
# 10	.0787	2.00	.0299	.76	+—3%	—15% to +30%	10%
# 12	.0661	1.68	.0272	.69	+—3%	—15% to +30%	10%
# 14	.0555	1.41	.0240	.61	+—3%	—15% to +30%	10%
# 16	.0469	1.19	.0213	.54	+—3%	—15% to +30%	10%
# 18	.0394	1.00	.0189	.48	+—3%	—15% to +30%	10%
# 20	.0331	.84	.0165	.42	+—5%	—15% to +30%	25%
# 25	.0280	.71	.0146	.37	+—5%	—15% to +30%	25%
# 30	.0232	.59	.0130	.33	+—5%	—15% to +30%	25%
# 35	.0197	.50	.0114	.29	+—5%	—15% to +30%	25%
# 40	.0165	.42	.0098	.25	+—5%	—15% to +30%	25%
# 45	.0138	.35	.0087	.22	+—5%	—15% to +30%	25%
# 50	.0117	.297	.0074	.188	+—6%	—15% to +85%	40%
# 60	.0098	.250	.0064	.162	+—6%	—15% to +35%	40%
# 70	.0083	.210	.0055	.140	+—6%	—15% to +35%	40%
# 80	.0070	.177	.0047	.119	+—6%	—15% to +35%	40%
#100	.0059	.149	.0040	.102	+—6%	—15% to +35%	40%
#120	.0049	.125	.0034	.086	+—6%	—15% to +35%	40%
#140	.0041	.105	.0029	.074	+—8%	—15% to +35%	60%
#170	.0035	.088	.0025	.063	+—8%	—15% to +35%	60%
#200	.0029	.074	.0021	.053	+—8%	—15% to +35%	60%
#230	.0024	.062	.0018	.046	+—8%	—15% to +35%	90%
#270	.0021	.053	.0016	.041	+—8%	—15% to +35%	90%
#325	.0017	.044	.0014	.036	+—8%	—15% to +35%	90%

COARSE AGGREGATE STANDARD SIZES

Simplified Practice Recommendation R163-39

Size No.	Nominal Size Square Openings	Amounts finer than each Laboratory Sieve (Square Openings) Percentage by Weight 3″	2½″	2″	1½″	1″	¾″	½″	⅜″	No. 4	No. 8	No. 16	No. 100
2	2½″-1½″	100	90-100	35-70	0-15		0-5						
3	2″-1″		100	90-100	35-70	0-15		0-5					
5	1″-⅜″				100	90-100	40-75	15-35	0-15	0-5			
68	¾″-No. 8					100	90-100		30-65	5-25	0-5		
79	½″-No. 8						100	90-100	40-75	5-25	0-5		
8	⅜″-No. 8							100	85-100	10-30	0-10		
9	No. 4-No. 16								100	85-100	10-40	0-10	
10	No. 4-0								100	85 100			10-30

Typical Uses of Above Sizes

Uses	Size Number 2	3	5	68	79	8	9	10
Water-bound Macadam—Coarse Aggregate	x	x						
Filler								x
Drag Levelling Course				x				
Surface Treatment						x	x	
Seal Coat				x	x	x		
Re-Tread—Mix			x					
Choke							x	
Seal						x	x	
Penetration Macadam—Coarse Aggregate		x						
Choke					x			
Seal					x	x		
Cold Patch				x				

SHIPPING DATA (PAGE 2)

(Summary of Data Received at Press Time)

Make and Model	Weight (Lbs.)	Width	Length	Height
Trojan Patrol Model PM-10-48 (Equipped with enclosed cab)	10,800 (16)	6'7"	18'0"	8'8"
Galion (Highway or Railway Shipping)				
116-D	23,285	7'8½"	25'8"	7'8½" (18)
102-D	21,700	7'7½"	25'5"	7'7½" (18)
201-D	17,900	7'5"	25'2"	6'8" (18)
402-G	8,150	6'0"	17'8"	6'6" (18)
Riddell (Highway or Railway Shipping)				
Warco Grader D-76	22,525	7'11"	26'6"	9'10"
Warco Grader VD-900	20,500	7'11"	25'6½"	9'10"
POWER SHOVELS				
Austin-Western (Highway Shipping)				
Badger Shovel	22,775 (19)	8'0"	16'3½" (20)	9'5"
Badger Trench Hoe	23,300 (19)	8'0"	16'3½" (21)	9'5"
Badger Skimmer	24,580 (19)	8'0"	16'3½" (22)	9'5"
Badger Crane	21,470 (19)	8'0"	16'3½" (23)	9'5"
Badger Dragline	22,350 (19)	8'0"	16'3½" (23)	9'5"
Badger Clamshell	23,100 (19)	8'0"	16'3½" (23)	9'5"
Badger Pile Driver	24,700 (19)	8'0"	16'3½" (23)	9'5"
Austin-Western (Railway Shipping)				
Badger Shovel	23,275 (19)	8'0"	16'3½" (20)	9'5"
Badger Trench Hoe	23,800 (19)	8'0"	16'3½" (21)	9'5"
Badger Skimmer	25,080 (19)	8'0"	16'3½" (22)	9'5"
Badger Crane	21,970 (19)	8'0"	16'3½" (23)	9'5"
Badger Dragline	22,850 (19)	8'0"	16'3½" (23)	9'5"
Badger Clamshell	23,600 (19)	8'0"	16'3½" (23)	9'5"
Badger Pile Driver	25,200 (19)	8'0"	16'3½" (23)	9'5"
Bucyrus-Erie (Highway Shipping)				
10-B ⅜-yd. Shovel	18,800	7'8"	23'0"	9'9"
15-B ½-yd. Shovel	26,000	7'11½"	27'0"	10'0"
22-B ¾-yd. Shovel	41,000	9'4"	31'0"	10'2"
38-B 1½-yd. Shovel	97,000	10'6"	40'0"	11'10½"
54-B 2½-yd. Shovel	159,000	11'9"	47'0"	12'7"
Bucyrus-Erie (Railway Shipping)				
10-B ⅜-yd. Shovel	19,500	7'8"	23'0"	9'9"
15-B ½-yd. Shovel	27,000	7'11½"	27'0"	10'0"
22-B ¾-yd. Shovel	42,000	9'4"	31'0"	10'2"
38-B 1½-yd. Shovel	98,500	10'6"	40'0"	11'10½"
54-B 2½-yd. Shovel	161,000	10'6"	47'0"	12'7"
Hanson (Highway Shipping)				
Model 31 Crawler ⅜-Yd.				
As a Shovel	23,500	8'0"	34'0"	9'0"
As a Crane	22,150	8'0"	38'0"	9'0"
As a Trench Hoe	23,000	8'0"	28'0"	10'0"
Model 41 Crawler ½-yd.				
As a Shovel	27,500	8'2"	37'0"	9'9"
As a Crane	26,000	8'2"	43'0"	9'9"
As a Trench Hoe	27,000	8'2"	31'0"	10'9"
Hanson (Railway Shipping)				
Model 31 Crawler ⅜-yd.				
As a Shovel	24,000	8'0"	34'0"	9'0"
As a Crane	24,000	8'0"	38'0"	9'0"
As a Trench Hoe	24,000	8'0"	28'0"	10'0"
Model 41 Crawler ½-Yd.				
As a Shovel	28,000	8'2"	37'0"	9'9"
As a Crane	27,000	8'2"	43'0"	9'9"
As a Trench Hoe	27,500	8'2"	31'0"	10'9"
Insley (Highway Shipping)				
K12 ½-yd. Shovel (24)	26,000	8'2"	26'0"	10'0"
K-12 Dragline (24)	23,800	8'2"	41'0"	10'0"
Insley (Railway Shipping)				
K12 ½-yd. Shovel (24)	26,000	8'2"	26'0"	10'0"
K12 Dragline (24) (26)	23,800	8'2"	12'6" (25)	10'0"
Koehring (Highway or Railway Shipping)				
½-yd. (27) (28)	24,450	9'0"	11'5"	10'2"
½-yd. (27) (29)	23,170	8'0"	11'5"	10'2"
¾-yd. (27) (30)	37,250	9'7"	15'2"	11'0"
¾-yd. (27) (28)	39,170	10'6"	15'2"	11'0"
¾-yd. (27) (31)	41,260	11'0"	15'6"	11'0"
1½-yd. (27) (28)	81,850	10'10"	17'8"	13'0"
1½-yd. (27) (31)	85,650	11'4"	18'6"	13'0"
Lima (Highway Shipping)				
Type 34	39,100 to 43,500	8'7"	14'6" (27)	10'5"
Type 604	78,000 to 85,350	10'6"	18'7" (27)	12'3"
Type 802	132,500 to 162,500	11'4"	20'10" (27)	11'9"
Type 1201	191,000 to 216,000	13'1"	24'6" (27)	12'11"
Lima (Railway Shipping)				
Type 34	39,900 to 44,300	8'7"	14'6" (27)	10'5"
Type 604	79,000 to 86,350	....	18'7" (27)	12'3"
Type 802	134,000 to 164,000	10'2"	20'10" (27)	11'9"
Type 1201	193,000 to 218,000	10'6"	24'6" (27)	12'11"
Marion (Railway Shipping)				
362 Shovel (32)	91,000 (33)	11'4" (34)	34'5" (35)	22'5" (35)
33-M Shovel	43,000	9'10"	26'10" (35)	18'2" (35)
Michigan (Highway Shipping)				
Model T-6-K				
As a Shovel	23,400	7'11"	27'7"	9'11"
As a Hoe	23,600	7'11"	16'1"	11'6"
As a Crane	21,575	7'11"	32'5"	10'4"
As a Clam	21,775	7'11"	33'9"	10'4"
As a Dragline	21,800	7'11"	33'2"	10'4"
Model TMDT-16				
As a Shovel	31,500	7'11"	32'4"	10'6"
As a Hoe	31,500	7'11"	29'0"	12'10"
As a Crane	29,675	7'11"	36'10"	10'6"
As a Clam	29,815	7'11"	38'2"	10'6"
As a Dragline	29,925	7'11"	36'2"	10'6"
Model TLDT-20				
As a Crane	34,525	7'11"	37'0"	10'6"
As a Clam	34,515	7'11"	38'4"	10'6"
As a Dragline	34,625	7'11"	36'4"	10'6"
Model C-16 (29)				
As a Shovel	25,000	7'10" (36)	32'4"	9'0"
As a Hoe	25,000	7'10" (36)	29'0"	11'4"
As a Crane	23,175	7'10" (36)	36'10"	9'0"
As a Clam	23,315	7'10" (36)	38'2"	9'0"
As a Dragline	23,425	7'10" (36)	36'10"	9'0"
Michigan (Railway Shipping)				
Model T-6-K				
As a Shovel		7'11½"	32'0"	9'6"
As a Hoe		7'11½"	33'7"	11'6"
As a Crane		7'11½"	39'1"	9'6"
As a Clam		7'11½"	39'1"	9'6"
As a Dragline		7'11½"	39'1"	9'6"
Model TMDT-16				
As a Shovel		7'11"	42'4"	10'6"
As a Hoe		7'11"	39'0"	12'10"
As a Crane		7'11"	44'0"	10'6"
As a Clam		7'11"	44'0"	10'6"
As a Dragline		7'11"	44'0"	10'6"
Model TLDT-20				
As a Crane		7'11"	44'0"	10'6"
As a Clam		7'11"	44'0"	10'6"
As a Dragline		7'11"	44'0"	10'6"
Model C-16 (29)				
As a Shovel		7'10" (36)	29'6"	9'0"
As a Hoe		7'10" (36)	29'8"	12'10"
As a Crane		7'10" (36)	36'10"	9'0"
As a Clam		7'10" (36)	36'10"	9'0"
As a Dragline		7'10" (36)	36'10"	9'0"
Wayne (Highway Shipping)				
Shovel	27,058	8'0"	30'0"	9'9"
Trench Hoe	27,090	8'0"	28'0"	9'9"

SHIPPING DATA
(PAGE 3)

(Summary of Data Received at Press Time)

Make and Model	Weight (Lbs.)	Width	Length	Height
Clamshell (26)	27,181	8'0"	41'9"	9'9"
Crane	27,088	8'0"	41'9"	9'9"
Dragline (26)	27,189	8'0"	41'9"	9'9"

Wayne (Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
Shovel	27,058	8'0"	32'0"	9'9"
Trench Hoe	27,090	8'0"	32'0"	9'9"
Clamshell (26)	27,181	8'0"	41'9"	9'9"
Crane	27,088	8'0"	41'9"	9'9"
Dragline (26)	27,189	8'0"	41'9"	9'9"

ROAD ROLLERS

Austin-Western (Highway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
5-8 Ton Tandem	11,950 (37)	5'1⅝"	14'6"	7'2¼"
8-10½ Ton Tandem	16,800 (37)	5'1⅝"	14'6"	7'2¼"
6 Ton Cadet	12,205 (38)	5'5¾"	14'11½"	6' ½"
7 Ton Cadet	14,350 (38)	5'5¾"	14'11¼"	6' ½"
8 Ton Cadet	16,358 (38)	5'5¾"	14'11¾"	6'1½"
10 Ton Autocrat	20,765 (39)	7'1¼"	18'1⅜"	6'5"
12 Ton Autocrat	24,275 (39)	7'1¼"	18'1⅜"	6'5"

Austin-Western (Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
5-8 Ton Tandem	12,350 (37)		14'6"	7'2¼"
8-10½ Ton Tandem	17,200 (37)		14'6"	7'2¼"
6 Ton Cadet	12,605 (38)		14'11½"	6' ½"
7 Ton Cadet	14,750 (38)		14'11¼"	6' ½"
8 Ton Cadet	16,758 (38)		14'11¾"	6'1½"
10 Ton Autocrat	21,165 (39)		18'1⅜"	6'5"
12 Ton Autocrat	24,675 (39)		18'1⅜"	6'5"

Buffalo-Springfield (Highway or Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
KT-5	3,160	3'8"	8'5"	5'6"
KT-6	4,125	3'8"	8'5"	5'6"
KT-7	6,475	4'½"	10'4"	5'6"
KT-16B	11,650	5'5½"	14'6½"	7'1½"
KT-17B	12,334	5'5½"	14'6½"	7'1½"
KT-18B	16,265	5'5½"	14'6½"	7'1½"
KT-24B	16,885	5'9½"	16'3"	7'9½"
KT-25B	20,000	5'9½"	16'3"	7'9½"
VT-48	30,375	6'4"	20'7"	8'9⅜"
KX-25	25,420	5'9½"	21'8"	7'9½"
VM-18	10,000	5'3"	15'9¾"	5'6"
VM-19	12,000	5'3"	15'9¾"	5'6"
VM-21	14,000	5'7"	16'0"	5'8½"
VM-24	16,000	5'7"	16'0"	5'8½"
VM-31	21,765	6'4⅜"	18'6½"	6'5½"
VM-32	24,405	6'4⅜"	18'6½"	6'5½"
TR-3	6,270	6'8⅛" (40)	13'4¼"	5'9"

C. H. & E. Mfg. Co. (Highway or Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
3 Ton Tandem	5,000	3'9"	8'4"	4'9"

Galion (Highway or Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
12 Ton Chief	24,000	6'4"	17'3"	6'8½"
10 Ton Chief	20,000	6'4"	17'3"	6'8½"
8 Ton Warrior	16,000	5'10"	16'0"	6'7"
7 Ton Warrior	14,000	5'10"	16'0"	6'7"
6 Ton Warrior	12,000	5'10"	15'11"	6'4½"
10 Ton Tandem	20,000	5'8½"	15'10"	7'11"
8 Ton Tandem	16,000	5'8½"	15'10"	7'11"
5 Ton Tandem	10,000	5'5½"	14'3"	7'3½"
3 Ton Tandem	7,240	4'3"	10'5¾"	6'2"
Portable Roller	6,700	4'3"	10'5¾"	6'2"

Huber (Highway or Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
5 Ton 3 Wheel	11,318	5'7"	13'11"	5'2"
6 Ton 3 Wheel	12,266	5'7"	13'11"	5'2"
8 Ton 3 Wheel	16,954	5'11"	14'6"	5'10"
10 Ton 3 Wheel	20,392	6'5"	18'3"	6'2"
3-4 Ton Tandem	6,532	4'0"	10'8"	5'7"
5-8 Ton Tandem	10,468	5'3"	14'5"	7'1"
8-12 Ton Tandem	16,344	5'6"	16'7"	8'10"

Littleford (Highway or Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
Portable	4,400	5'0"	7'9"	5'3"

Riddell (Highway or Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
HR-6	12,500	5'8"	14'4½"	5'3¾"
HR-7	14,250	5'8"	14'4½"	5'3¾"
HR-8	16,300	5'10"	16'4"	5'3¾"
HR-10	20,800	6'2"	18'0"	6'3¼"
HR-12	24,300	6'2"	18'0"	6'3¼"

Tampo (Highway or Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
6-8 Ton 3 Wheel	12,000	5'10"	15'0"	4'9½"
8-10 Ton 3 Wheel	16,000	6'8"	16'0"	6'3"
10-12 Ton 3 Wheel	20,000	6'8"	16'0"	6'4"

SCRAPERS

American Tractor (Highway or Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
H-51	5,800	7'2"	20'0"	5'10"
H-52	5,685	7'2"	20'0"	5'10"
H-61	6,750	7'10"	20'2"	6'0"
H-62	6,650	7'10"	20'2"	6'0"
H-71	8,400	9'6"	20'5"	6'2"
H-72	8,100	9'6"	20'5"	6'2"
H-81	9,400	9'6"	20'9"	6'4"
H-101	11,000	9'6"	21'1"	6'8"

Bucyrus-Erie (Highway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
S-46	8,450	7'9"	21'11"	7'5"
S-68	11,000	8'11"	24'0"	8'0½"
S-91	15,000	9'11"	26'6"	8'11"
S-113	18,950	10'9"	29'3"	9'9"
S-152	23,500	11'8"	31'3"	10'6"
B-170	26,950	12'3"	34'3"	10'11"
B-250	37,500	12'6"	41'2"	12'6"
G-38	5,200	8'4¾"	13'2¼"	4'4¼"
G-58	7,000	9'11"	13'8"	4'10"

Bucyrus-Erie (Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
S-46	8,700	7'9"	21'11"	7'5"
S-68	11,250	8'11"	24'0"	8'0½"
S-91	15,250	9'11"	26'6"	8'11"
S-113	19,200	10'9"	29'3"	9'9"
S-152	24,000	Partial Knockdown		
B-170	27,450	Partial Knockdown		
B-250	38,000	Partial Knockdown		
G-38	5,400	8'4¾"	13'2¼"	4'4¼"
G-58	7,200	9'11"	13'8"	4'10"

Caterpillar (Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
No. 80	26,000	11'6"	35'6"	9'7"
No. 70	18,800	10'0"	31'2"	8'5"
No. 60	12,300	8'9"	27'8"	7'9"
No. 10	17,330	10'0"	25'4"	8'10"

Gar Wood (Highway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
Model 23	3,160	7'6"	11'10¼"	4'0½"
Model 25	4,940	8'7¾"	13'9¼"	5'2"
Model 508	10,220	8'10"	18'11"	8'10"
Model 511	14,550	9'11"	23'1"	9'8"
Model 517	23,080	11'5½"	26'8"	8'10"
Model 524	28,600	11'5½"	27'6" (41) 28'11" (42)	9'7"
Model 528	29,420	11'5½"	28'6" (41) 28'11" (42)	9'7"

Gar Wood (Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
Model 23	3,190	7'6"	11'10¼"	4'0½"
Model 25	4,970	8'7¾"	13'9¼"	5'2"
Model 508	10,295	8'10"	18'11"	8'10"
Model 511	14,625	9'11"	23'1"	9'8"
Model 517	23,150	11'5½"	26'8"	8'10"
Model 524	28,675	11'5½"	27'6" (41) 28'11" (42)	9'7"
Model 528	29,495	11'5½"	28'6" (41) 28'11" (42)	9'7"

Heil (Highway or Railway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
OC-6	10,000 (43)	8'0"	24'10"	6'3"
OC-9	13,500 (43)	9'4"	28'7½"	6'6"
OC-11	15,500 (43)	10'4"	28'7½"	6'8"
OC-16	21,500 (43)	11'0"	33'9"	8'0"
OC-25	35,800 (43)	12'0"	38'9½"	9'2½"

LaPlant-Choate (Highway Shipping)

Make and Model	Weight (Lbs.)	Width	Length	Height
C22	2,855	5'11"	12'0"	3'11"
C24	2,795	5'11"	16'0"	3'11"
C42	6,840	7'8¾"	17'1½"	5'8¼"
C44	6,930	7'8¾"	22'7"	5'8¼"

TANK CAPACITIES IN GALLONS

Number of Gallons Contained in Full Cylindrical Tanks of Various Sizes

Courtesy of Pioneer Engineering Works, Minneapolis, Minn.

Diam. in Feet	LENGTH OR DEPTH IN FEET												
	5	6	7	8	9	10	11	12	13	14	15	16	17
1½	66	79	......	......	......	......	......	......	......	......	......	......	......
2	117	141	164	188	212	235	......	......	......	......	......	......	......
2½	184	220	257	294	330	367	404	441	......	......	......	......	......
3	264	317	370	423	476	529	582	635	687	......	......	......	......
3½	360	432	504	576	648	720	792	864	936	1008	1080	1152	......
4	470	564	658	752	846	940	1034	1128	1222	1316	1410	1504	1598
5	734	881	1028	1175	1322	1469	1616	1763	1909	2056	2203	2350	2497
6	1058	1269	1481	1692	1904	2115	2327	2538	2750	2961	3173	3384	3596
7	1439	1727	2015	2303	2591	2879	3167	3455	3742	4030	4318	4606	4894
8	1880	2256	2632	3008	3384	3760	4136	4512	4888	5264	5640	6016	6392
9	2379	2855	3331	3807	4283	4759	5235	5711	6187	6662	7138	7614	8090
10	2938	3525	4113	4700	5288	5875	6463	7050	7638	8225	8813	9400	9988
11	3555	4265	4976	5687	6398	7109	7820	8531	9242	9953	10664	11374	12085
12	4230	5076	5922	6768	7614	8460	9306	10152	10998	11844	12690	13536	14383
13	4964	5957	6950	7943	8936	9929	10922	11915	12908	13901	14894	15886	16879
14	5758	6909	8061	9212	10364	11515	12667	13818	14970	16121	17273	18424	19576
15	6610	7931	9253	10575	11897	13219	14541	15863	17185	18507	19828	21150	22472

TANK GAUGINGS

Table for Determining the Amount of Liquid in Partly Filled Horizontal Cylindrical Tanks

Especially prepared for Powers' Road and Street Catalog

Pct. of Depth Filled	Pct. of Capacity Filled	Pct. of Depth Filled	Pct. of Capacity Filled	Pct. of Depth Filled	Pct. of Capacity Filled	Pct. of Depth Filled	Pct. of Capacity Filled
1	0.20	26	20.73	51	51.27	76	81.50
2	0.50	27	21.86	52	52.55	77	82.60
3	0.90	28	23.00	53	53.81	78	83.68
4	1.34	29	24.07	54	55.08	79	84.74
5	1.87	30	25.31	55	56.34	80	85.77
6	2.45	31	26.48	56	57.60	81	86.77
7	3.07	32	27.66	57	58.86	82	87.76
8	3.74	33	28.84	58	60.11	83	88.73
9	4.45	34	30.03	59	61.36	84	89.68
10	5.20	35	31.19	60	62.61	85	90.60
11	5.98	36	32.44	61	63.86	86	91.50
12	6.80	37	33.66	62	65.10	87	92.36
13	7.64	38	34.90	63	66.34	88	93.20
14	8.50	39	36.14	64	67.56	89	94.02
15	9.40	40	37.39	65	68.81	90	94.80
16	10.32	41	38.64	66	69.97	91	95.55
17	11.27	42	39.89	67	71.16	92	96.26
18	12.24	43	41.14	68	72.34	93	96.93
19	13.23	44	42.40	69	73.52	94	97.55
20	14.23	45	43.66	70	74.69	95	98.13
21	15.26	46	44.92	71	75.93	96	98.66
22	16.32	47	46.19	72	77.00	97	99.10
23	17.40	48	47.45	73	78.14	98	99.50
24	18.50	49	48.73	74	79.27	99	99.80
25	19.61	50	50.00	75	80.39	100	100.00

SPECIFIC GRAVITY CONVERTED INTO POUNDS PER GALLON

From "Bituvia," a Pocket Book of Reilly Tar and Chemical Corp., Indianapolis, Ind.

Specific Gravity 60°/60° F.	Lbs. Per Gal.	Specific Gravity 60°/60° F.	Lbs. Per Gal.
1.000	8.328	1.155	9.619
1.005	8.370	1.160	9.661
1.010	8.412	1.165	9.702
1.015	8.453	1.170	9.744
1.020	8.495	1.175	9.786
1.025	8.536	1.180	9.827
1.030	8.578	1.185	9.869
1.035	8.620	1.190	9.911
1.040	8.661	1.195	9.952
1.045	8.703	1.200	9.994
1.050	8.745	1.205	10.036
1.055	8.786	1.210	10.077
1.060	8.828	1.215	10.119
1.065	8.870	1.220	10.160
1.070	8.911	1.225	10.202
1.075	8.953	1.230	10.244
1.080	8.995	1.235	10.285
1.085	9.036	1.240	10.327
1.090	9.073	1.245	10.369
1.095	9.119	1.250	10.410
1.100	9.161	1.255	10.452
1.105	9.203	1.260	10.494
1.110	9.244	1.265	10.535
1.115	9.286	1.270	10.577
1.120	9.328	1.275	10.619
1.125	9.369	1.280	10.660
1.130	9.411	1.285	10.702
1.135	9.453	1.290	10.743
1.140	9.494	1.295	10.785
1.145	9.536	1.300	10.827
1.150	9.578		

GALLONS OF BITUMINOUS MATERIAL REQUIRED PER MILE FOR VARIOUS WIDTHS OF ROAD AT VARIOUS RATES OF APPLICATION

From Koppers Tarmac Handbook, published by Tar and Chemical Division, Koppers Co., Pittsburgh, Pa.

Width of Road	Sq. Yards per Mile	RATES OF APPLICATION (Gallons Per Square Yard)														
		1/10	15/100	1/5	1/4	3/10	1/3	35/100	4/10	45/100	1/2	6/10	2/3	7/10	3/4	8/10
		.10	.15	.20	.25	.30	.333	.35	.40	.45	.50	.60	.667	.70	75	80
6′	3520.0	352	528	704	880	1056	1173	1232	1408	1584	1760	2112	2347	2464	2640	2816
7′	4106.6	411	616	821	1027	1232	1369	1437	1643	1848	2053	2464	2738	2875	3080	3285
8′	4693.3	469	704	939	1173	1408	1564	1643	1877	2112	2347	2816	3129	3285	3520	3755
9′	5280.0	528	792	1056	1320	1584	1760	1848	2112	2376	2640	3168	3520	3696	3960	4224
10′	5866.6	587	880	1173	1467	1760	1956	2053	2347	2640	2933	3520	3911	4107	4400	4693
11′	6453.3	645	968	1291	1613	1936	2151	2259	2581	2904	3227	3872	4302	4517	4840	5163
12′	7040.0	704	1056	1408	1760	2112	2347	2464	2816	3168	3520	4224	4693	4928	5280	5632
14′	8213.3	821	1232	1643	2053	2464	2738	2875	3285	3696	4107	4928	5476	5749	6160	6571
16′	9386.6	939	1408	1877	2347	2816	3129	3285	3755	4224	4694	5632	6258	6571	7040	7509
18′	10560.0	1056	1584	2112	2640	3168	3520	3696	4224	4752	5280	6336	7040	7392	7920	8448
20′	11733.3	1173	1760	2347	2933	3520	3911	4107	4693	5280	5867	7040	7822	8213	8800	9387
22′	12906.6	1291	1936	2581	3227	3872	4302	4517	5163	5808	6453	7744	8604	9035	9680	10325

Width of Road	Sq. Yards per Mile	RATES OF APPLICATION (Gallons Per Square Yard)													
		9/10	1	1-1/10	1-1/5	1-1/4	1-3/10	1-4/10	1-1/2	1-3/4	2	2-1/4	2-1/2	2-3/4	3
		.90	1 00	1 10	1 20	1 25	1.30	1.40	1.5	1 75	2.0	2.25	2.5	2.75	3.0
6′	3520.0	3168	3520	3870	4224	4400	4576	4928	5280	6160	7040	7920	8800	9680	10560
7′	4106.6	3696	4107	4517	4928	5133	5339	5749	6160	7187	8213	9240	10267	11293	12320
8′	4693 3	4224	4693	5163	5632	5867	6101	6571	7040	8213	9387	10560	11733	12907	14080
9′	5280 0	4752	5280	5808	6336	6600	6864	7392	7920	9240	10560	11880	13200	14520	15840
10′	5866.6	5280	5867	6453	7040	7333	7627	8213	8800	10267	11733	13200	14667	16133	17600
11′	6453 3	5808	6453	7099	7744	8067	8389	9035	9680	11293	12907	14520	16133	17747	19360
12′	7040 0	6336	7040	7744	8448	8800	9152	9856	10560	12320	14080	15840	17600	19360	21120
14′	8213.3	7392	8213	9035	9856	10267	10677	11499	12320	14373	16427	18480	20533	22587	24640
16′	9386 6	8448	9387	10325	11264	11733	12203	13141	14080	16427	18773	21121	23467	25813	28160
18′	10560 0	9504	10560	11616	12672	13200	13728	14784	15840	18480	21120	23760	26400	29040	31680
20′	11733 3	10560	11733	12907	14080	14667	15253	16427	17600	20533	23467	26400	29333	32266	35200
22′	12906 6	11616	12907	14197	15488	16133	16779	18069	19360	22587	25813	29040	32267	35493	38720

WEIGHT OF ASPHALT-FELT JOINTS

The best known types of asphalt-felt expansion joints have approximately the following weights per 100 linear feet.

Width. In.	Thickness ¼ In. Lb.	⅜ In. Lb.	½ In. Lb.	¾ In. Lb.	1 In. Lb.
3	36	51	68	105	142
3½	42	59	79	122	165
4	47	68	90	140	189
5	59	85	112	175	237
6	71	102	135	210	284
7	83	119	157	245	332
8	95	136	180	280	379

Width. In.	Thickness ¼ In. Lb.	⅜ In. Lb.	½ In. Lb.	¾ In. Lb.	1 In. Lb.
9	106	153	202	315	426
10	118	170	225	350	474
11	130	187	248	385	533
12	142	204	270	420	570

Crating and packing for shipment adds about 20% to the above weights.

DESIGN OF STRUCTURAL CONCRETE MIXES

Concrete Information No. ST 56
Courtesy of the Portland Cement Association

A SIMPLE PROCEDURE for designing concrete mixes is given in "Proposed Recommended Practice for the Design of Concrete Mixes", *Journal of the American Concrete Institute*, November, 1943. Tables I through IV below have been taken from that report. Table V has been adapted from Table 5 of the report. The procedure involves the following steps:

STEP 1. Select water-cement ratio* necessary to produce concrete having required durability and specified strength. See Table I for recommended values for various types of construction and exposure conditions. Water-cement ratio for specified strength should be determined by test. When this is not practicable, values may be selected from Table II. The lower of the values selected from Tables I and II or determined by test should be used.

STEP 2. Select a suitable consistency. Use the lowest slump compatible with proper placing. Recommended values are given in Table III.

STEP 3. Determine maximum size of aggregate. Maximum size should be as large as practicable and available but should not exceed two-thirds minimum clear distance between reinforcement. Recommended limits are given in Table IV.

STEP 4. Select the trial mix from Table V. Quantities in Table V are based on saturated, surface-dry aggregates. Correction must be made for surface moisture carried by the aggregates. Use the selected mix for the first batch or two but add only enough water to give the desired slump.

STEP 5. Make adjustments in succeeding batches. If amount of water used in Step 4 is more than for the water-cement ratio, decrease the amounts of aggregate added to the batch, and if it is less, increase the amounts of aggregate. It may be desirable also to increase or decrease the percentage of sand slightly to secure the most suitable mix for conditions prevailing on the job. An undersanded mix is indicated by harshness, difficulty in placing, and by stone pockets and honeycomb in the hardened concrete. An oversanded mix is indicated by an excess of mortar.

EXAMPLE. An example will serve to illustrate the procedure outlined above. Assume that a thin (8-in.) plain concrete wall is to be built, where climatic conditions are severe, a minimum strength of 3,000 p.s.i. is to be provided, stone sand of medium grading having 3 per cent moisture and gravel having ½ per cent moisture are to be used. Vibrators will be used. Table I indicates that not more than 6½ gal. of water per sack of cement should be used for the exposure conditions. Table II indicates that not more than 7¼ gal. of water per sack of cement should be used to produce the necessary strength. The 6½-gal. mix therefore will be selected. Table III indicates that 2- to 5-in. slump can be used, say 3 in., with hand-placing and this can be reduced by one-third, say to 2 in., for vibration. Table IV indicates that coarse aggregate can be graded to 1½ in. From Table V it is found that for 6½ gal. per sack of cement, about 34 gal. of water and 3,300 lb. of aggregate per cu.yd. of concrete will be used, with natural sand and gravel of these gradings and for a 3-in. slump. The fine aggregate is given as 37 per cent of the total but this percentage must be increased by 3, to 40 per cent because stone sand is to be used. The cement factor will be 34/6.5 = 5.23 sacks per cu.yd. For 2-in. slump, the water should be reduced by 3 per cent or about 1 gal. and for stone sand, the water should be increased by 15 lb. or 1.8 gal., making a net increase of 0.8 gal., to 34.8 gal. The cement required would then be 34.8/6.5 = 5.35 sacks per cu.yd. of concrete. Since the water is increased by 0.8 gal. and the cement is increased by 5.35 − 5.23 = 0.12 sack, the amount of aggregate should be reduced correspondingly. The following rules may be applied for making this adjustment:

For each gallon increase or decrease in water content, subtract or add 22 lb. of aggregate.

For each sack increase or decrease in cement, subtract or add 80 lb. of aggregate.

Adjustment in above example will be:

3,300 − [(22 × 0.8) + (80 × 0.12)] = 3,300 − 27 = 3,273 lb. surface-dry aggregate

Then:

Weight of dry fine aggregate	= 3,273 × 0.40	= 1,309 lb.
Weight of dry coarse aggregate	= 3,273 × 0.60	= 1,964 lb.
Weight of damp fine aggregate	= 1,309 × 1.03	= 1,348 lb.
Weight of damp coarse aggregate	= 1,964 × 1.005	= 1,974 lb.

Moisture in aggregate = (1,348 − 1,309) + (1,974 − 1,964) = 49 lb.
Water to be added to 1-cu.yd. batch = 34.8 − 49/8.33 = 28.9 gal.
Then trial field quantities = 1,348 lb. damp sand, 1,974 lb. damp gravel, 28.9 gal. added water, and 5.35 sacks cement per cu.yd. of concrete.

If it is found, upon trying this mix, that more or less water is necessary for the required slump, adjustment can be made by decreasing or increasing the amount of aggregate, applying the above rules. Thus, suppose that 26.1 gal. added to above quantities of cement and damp aggregate gives desired slump. Then, adding moisture in aggregate, total water will be 26.1 + 49/8.33 = 32.0 gal. or 34.8 − 32.0 = 2.8 gal. less than estimated for above batch. The yield of concrete will be 27 − 2.8/7.5 = 26.63 cu.ft. and water content will be (27/26.63) × 32 = 32.4 gal. per cu.yd. The corrected cement factor will be 32.4/6.5 = 5.0 sacks per cu.yd. Since water has been decreased 34.8 − 32.4 = 2.4 gal. and cement decreased 5.35 − 5.00 = 0.35 sack, the aggregate can be increased by (22 × 2.4) + (80 × 0.35) = 81 lb., and total dry aggregate will be 3,273 + 81 = 3,354 lb. Correction should be made also for moisture as outlined above. In this example:

Weight of dry fine aggregate	= 3,354 × 0.40	= 1,342 lb.
Weight of dry coarse aggregate	= 3,354 × 0.60	= 2,012 lb.
Weight of damp fine aggregate	= 1,342 × 1.03	= 1,382 lb.
Weight of damp coarse aggregate	= 2,012 × 1.005	= 2,022 lb.

Moisture in aggregate = (1,382 − 1,342) + (2,022 − 2,012) = 50 lb.
Water to be added to 1-cu.yd. batch = 32.4 − 50/8.33 = 26.4 gal.
Then adjusted field quantities = 1,382 lb. damp sand, 2,022 lb. damp gravel, 26.4 gal. added water, and 5.0 sacks cement per cu.yd. of concrete.

NOTE: Table V, above example, and discussion are based on aggregates having specific gravity of 2.65. Most sands, gravels and crushed rocks vary so little from this average value as to introduce little error in the trial mix proportions. The adjustment in mix outlined above will correct such errors.

*In Canada a sack of cement weighs 87½ lb. compared to 94 lb. in United States, and the Imperial gallon is equivalent to 1.2 U. S. gallons. To convert water-cement ratios given herein to Canadian units, multiply by 0.78. Thus 5 gal. per sack becomes 3.9 Imperial gallons per Canadian sack of cement.

TABLE I. NET WATER-CEMENT RATIOS FOR VARIOUS TYPES OF CONSTRUCTION AND EXPOSURE CONDITIONS*

Type or location of structure	Severe or moderate climate, wide range of temperature, rain, and long freezing spells or frequent freezing and thawing					Mild climate, rain or semiarid; rarely snow or frost				
	Thin sections, gal. per sack		Moderate sections, gal. per sack		Heavy and mass sections, gal. per sack	Thin sections, gal. per sack		Moderate sections, gal. per sack		Heavy and mass sections, gal. per sack
	Reinf.	Plain	Reinf.	Plain		Reinf.	Plain	Reinf.	Plain	
A. At the water line in hydraulic or waterfront structures or portions of such structures where complete saturation or intermittent saturation is possible, but not where the structure is continuously submerged:										
In sea water	5	5½	5½	6	6	5	5½	5½	6	6
In fresh water	5½	6	6	6½	6½	5½	6	6	6½	6½
B. Portions of hydraulic or waterfront structures some distance from the water line, but subject to frequent wetting:										
By sea water	5½	6	6	6	6	5½	6½	6½	7	7
By fresh water	6	6½	6½	6½	6½	6	7	7	7½	7½
C. Ordinary exposed structures, buildings and portions of bridges not coming under above groups	6	6½	6½	7	7	6	7	7	7½	7½
D. Complete continuous submergence:										
In sea water	6	6½	6½	7	7	6	6½	6½	7	7
In fresh water	6½	7	7	7½	7½	6½	7	7	7½	7½
E. Concrete deposited through water	**	**	5½	5½	5½	**	**	5½	5½	5½
F. Pavement slabs directly on ground:										
Wearing slabs	5½	6	**	**	**	6	6½	**	**	**
Base slabs	6½	7	**	**	**	7	7½	**	**	**
G. Special case: For concrete not exposed to the weather, such as interiors of buildings and portions of structures entirely below ground, no exposure hazard is involved, and the water-cement ratio should be selected on the basis of the strength and workability requirements.										

*Adapted from Table 1 of the 1940 Joint Committee "Report on Recommended Practice and Standard Specifications for Concrete and Reinforced Concrete".
**These sections not practicable for the purpose indicated.

TABLE II. COMPRESSIVE STRENGTH FOR VARIOUS WATER-CEMENT RATIOS*

Net water-cement ratio		Probable strength at 28 days, p.s.i.
By weight	Gal. per sack cement	
0.44	5	5,000
0.49	5½	4,500
0.53	6	4,000
0.58	6½	3,600
0.62	7	3,200
0.67	7½	2,800
0.71	8	2,500
0.75	8½	2,000

*Adapted from Table 2 of the 1940 Joint Committee "Report on Recommended Practice and Standard Specifications for Concrete and Reinforced Concrete".

TABLE III. RECOMMENDED SLUMPS FOR VARIOUS TYPES OF CONSTRUCTION*

Type of construction	Slump, in.**	
	Maximum	Minimum
Reinforced foundation walls and footings, and thin plain walls	5	2
Plain footings, caissons, and substructure walls	4	1
Slabs, beams, and reinforced walls	6	3
Building columns	6	3
Pavements	3	2
Heavy mass construction	3	1

*Adapted from Table 4 of the 1940 Joint Committee "Report on Recommended Practice and Standard Specifications for Concrete and Reinforced Concrete".
**When high-frequency vibrators are used, the values given should be reduced about one-third.

TABLE IV. MAXIMUM SIZE OF AGGREGATE RECOMMENDED FOR VARIOUS TYPES OF CONSTRUCTION

Minimum dimension of section, in.	Maximum size of aggregate*, in in., for:			
	Reinforced walls, beams and columns	Unreinforced walls	Heavily reinforced slabs	Lightly reinforced or unreinforced slabs
2½ to 5	½ to ¾	¾	¾ to 1	¾ to 1½
6 to 11	¾ to 1½	1½	1½	1½ to 3
12 to 29	1½ to 3	3	1½ to 3	3
30 or more	1½ to 3	6	1½ to 3	3 to 6

*Based on square screen openings.

MIX PROPORTIONS BY VOLUME

Sand as used on the job almost invariably contains moisture which causes considerable bulking in volume. The amount of bulking varies with the amount of moisture and the grading of the sand. The weight of 1 cu.ft. of dry sand may vary from 100 to 115 lb. or more. The weight of dry sand in 1 cu.ft. of damp sand may vary from below 70 lb. up to the weight of 1 cu.ft. of dry sand. Thus, there is a possible variation of over 50 per cent in the amount of dry sand in 1 cu.ft. of damp sand, depending on the grading, moisture content and specific gravity. This explains why it is impossible to give accurate estimates of trial mixes by volume. Measurement of aggregates by weight is the general practice and should be required on all important work.

On small jobs, Table V can be used as a basis for estimating trial mixes by volume by making two simple tests. With a container of known capacity (a 1-cu.ft. box can be used) determine the weight per cu.ft of the sand and coarse aggregate separately, measured damp and loose. Having selected a suggested mix by weight from Table V, correct these weights for the moisture present. Then divide the corrected total weight of each aggregate by the corresponding weight per cu.ft., which will give the cu.ft. of each aggregate. The procedure is illustrated by the following example.

From Table V, a mix of 205 lb. sand and 365 lb. gravel per sack of cement is suggested for 6 gal. of mixing water, 3-in. slump, 1½-in. gravel, and sand of medium grading. If the sand contains 4 per cent moisture and the gravel 1 per cent, the corrected weights will be 1.04 × 205 = 213 lb. sand and 1.01

$\times$ 365 = 369 lb. gravel. Assume for this illustration that the sand is found to weigh 90 lb. per cu.ft. and the gravel 100 lb. per cu.ft., damp, loose. Then 213/90 = 2.4 cu.ft. sand and 369/100 = 3.7 cu.ft. gravel would be the trial mix proportions by volume.

FUNDAMENTALS OF CONCRETE MAKING

The procedure for design of concrete mixes discussed above is based on observing certain fundamental principles of making concrete. They include:

1. Suitable materials.
2. Accurate measurement of materials.
3. Thorough mixing.
4. A workable mix.
5. Proper placing.
6. Adequate curing.

Use Good Materials. Sand, gravel, crushed stone or other aggregates for concrete work must be clean and free from clay, loam and dirt. Usually washed and screened materials assure best results. Mixing water should be clean enough to drink, unless tests or previous experience show it to be suitable.

Coarse materials give more economical results than finer materials. This is because each particle must be thoroughly coated by cement paste and less paste is required for a given volume of coarse particles than for the same volume of small particles. Best results are secured with graded aggregates, that is, aggregates containing particles ranging from fine to coarse, with the coarse predominating. Sufficient fine particles are necessary, however, to give workability and smooth surfaces. Generally, the sand should contain from 10 to 30 per cent of particles passing a 50-mesh sieve, but for thin walls and where it is required to produce smooth surfaces a minimum of 15 per cent is desirable.

Materials should be kept in separate piles. Cement should be kept in a dry place as in a building or on a raised platform and covered with tarpaulins.

Measure Materials Accurately. Each of the ingredients should be accurately measured. Portland cement is furnished in sacks weighing 94 lb., considered as 1 cu.ft. Fractional bags should not be used unless they are weighed for each batch. Weight measurement of aggregates gives by far the best results and should be required on all important work. Measurement by volume is permitted only on small jobs in which case a 1-cu.ft. box or other container of known volume may be used. Usually the proper amount of sand is measured by the box into one wheelbarrow and the proper amount of coarse aggregate into another, marking the level to which each is filled. The wheelbarrows are then filled to these levels for each batch, dispensing with the box.

Water can be measured by buckets or by the tank on the mixer if it has an accurate measuring device. The capacity of a bucket can be determined by filling it with water from a quart measure, placing a mark on the inside of the bucket to indicate the proper amount (1 qt. = ¼ gal.). If a measuring device on the mixer is used, find out how much water is measured at each setting on the dial. This is done by discharging the water measured at each dial setting into buckets of known capacity.

Mix Thoroughly. Mix concrete thoroughly and until the color is uniform and there is a uniform distribution of the materials. Do not overload mixers or operate them at speeds higher than recommended by the manufacturer. Continue mixing for at least 1 minute after all materials are in the mixer. Longer mixing gives more uniform results.

Use a Workable Mixture. Should the proportions of sand and coarse aggregate selected give a mixture which is not workable, they should be adjusted to produce a mixture suitable for the job but without exceeding the selected amount of mixing water. The concrete should be a plastic mass which holds together during handling and placing. Very stiff mixes can be used when concrete is placed by vibration. Mixtures which permit water to rise to the surface or permit mortar to separate from coarse material should be avoided. Lack of fine particles in sand is sometimes responsible for water separation and must be corrected by supplying additional fines.

Place Concrete Carefully. Handle and place concrete carefully to prevent the materials from separating. In general it should not be allowed to drop freely into place more than 3 or 4 ft. Place it in the forms where it is to stay, and in horizontal layers, usually not over 1 to 2 ft. thick. Do not allow the concrete to flow over long distances in the forms as this causes the materials to separate. Spade each layer to settle the concrete, release air, remove stone pockets and provide smooth surfaces along the forms.

Do not trowel or float concrete excessively while it is soft. Such working of the surface brings water and fine material to the top, which upon hardening has a tendency to check and crack. Best results are secured by allowing the concrete to stand until it is quite stiff before finishing.

Cure New Concrete. The chemical reactions between cement and water require time. Under favorable conditions of moisture and temperature these reactions continue indefinitely. Thus strength, hardness, watertightness, durability and other desirable qualities continue to improve under the right conditions.

For continued improvement concrete must be kept moist. When the water used in mixing is lost by evaporation, the chemical reactions cease. Concrete should be protected from early drying by leaving forms in place, covering exposed surfaces with wet sand, burlap or other materials and by sprinkling. This wet "curing" should be started as soon as possible without marring the surfaces and should be continued as long as possible—at least 5 days when normal portland cement is used and 2 days when high early strength portland cement or concrete is used.

Favorable temperature is the second requirement for continued improvement. The reactions between cement and water are more rapid at high than at low temperatures. Near freezing, the reactions almost cease. Concrete moist-cured at 70 deg. F. for a week may have twice the strength of similar concrete cured at 50 deg. F. In mildly cold weather, the water may be heated to raise the temperature of the concrete to 70 deg. F. In freezing weather, the water and aggregates should be heated so that the temperature of the mixed concrete is between 70 and 80 deg. F. It should then be kept above 70 deg. for 3 days or above 50 deg. for 5 days for normal portland cement concrete, and above 70 deg. for 2 days or 50 deg. for 3 days when high early strength portland cement or concrete is used. Salt or other chemicals should not be used to lower the freezing point of concrete.

TABLE V. SUGGESTED TRIAL MIXES FOR CONCRETE OF MEDIUM CONSISTENCY (3-in. Slump*)

Max. size of coarse agg., in.	Water, gal. per sack cement	USING ROUNDED COARSE AGGREGATE									USING ANGULAR COARSE AGGREGATE								
		Sand, per cent of total	Per sack cement		Per cu.yd. of concrete					Yield, cu.ft. conc. per sack cement	Sand, per cent of total	Per sack cement		Per cu.yd. of concrete					Yield, cu.ft. conc. per sack cement
			sand, lb.	gravel, lb.	water		cement, sacks	sand, lb.	gravel, lb.			sand, lb.	stone, lb.	water		cement, sacks	sand, lb.	stone, lb.	
					lb.	gal.								lb.	gal.				
With Fine Sand—Fineness Modulus 2.20-2.60†																			
¾	5	41	170	245	310	37	7.4	1260	1800	3.65	46	170	200	335	40	8.0	1360	1600	3.38
1	5	36	155	275	300	36	7.2	1115	1980	3.75	41	155	225	325	39	7.8	1210	1755	3.46
1½	5	32	150	320	280	34	6.8	1020	2180	3.97	37	155	260	305	37	7.4	1150	1925	3.65
2	5	29	150	360	270	32	6.4	960	2300	4.22	34	155	295	295	35	7.0	1085	2065	3.86
¾	5½	42	195	270	310	37	6.7	1310	1810	4.03	47	195	220	335	40	7.3	1420	1605	3.70
1	5½	37	180	305	300	36	6.5	1170	1985	4.15	42	180	250	325	39	7.1	1280	1775	3.80
1½	5½	33	170	350	280	34	6.2	1055	2170	4.36	38	175	290	305	37	6.7	1170	1945	4.03
2	5½	30	170	400	270	32	5.8	985	2320	4.66	35	175	325	295	35	6.4	1120	2080	4.22
¾	6	43	220	290	310	37	6.2	1360	1800	4.36	48	220	235	335	40	6.7	1475	1575	4.03
1	6	38	205	330	300	36	6.0	1230	1980	4.50	43	205	270	325	39	6.5	1330	1755	4.15
1½	6	34	195	380	280	34	5.7	1110	2165	4.74	39	200	310	305	37	6.2	1240	1920	4.36
2	6	31	195	435	270	32	5.3	1035	2300	5.10	36	200	355	295	35	5.8	1160	2060	4.66
¾	6½	44	245	315	310	37	5.7	1400	1795	4.74	49	245	255	335	40	6.2	1520	1580	4.36
1	6½	39	230	360	300	36	5.5	1265	1980	4.91	44	230	290	325	39	6.0	1380	1740	4.50
1½	6½	35	225	415	280	34	5.2	1170	2160	5.19	40	225	335	305	37	5.7	1280	1910	4.74
2	6½	32	220	470	270	32	4.9	1080	2300	5.51	37	225	380	295	35	5.4	1215	2050	5.00
¾	7	45	275	335	310	37	5.3	1460	1775	5.10	50	275	275	335	40	5.7	1570	1570	4.74
1	7	40	255	385	300	36	5.1	1300	1965	5.30	45	255	310	325	39	5.6	1430	1735	4.82
1½	7	36	245	435	280	34	4.9	1200	2130	5.51	41	250	360	305	37	5.3	1325	1910	5.10
2	7	33	245	495	270	32	4.6	1125	2275	5.87	38	250	410	295	35	5.0	1250	2050	5.40
¾	7½	46	305	360	310	37	4.9	1495	1765	5.51	51	305	290	335	40	5.3	1615	1540	5.10
1	7½	41	280	405	300	36	4.8	1345	1945	5.63	46	280	330	325	39	5.2	1460	1715	5.19
1½	7½	37	275	470	280	34	4.5	1240	2115	6.00	42	280	385	305	37	4.9	1370	1890	5.51
2	7½	34	270	525	270	32	4.3	1160	2260	6.28	39	275	430	295	35	4.7	1290	2020	5.75
¾	8	47	335	380	310	37	4.6	1540	1750	5.87	52	330	305	335	40	5.0	1650	1525	5.40
1	8	42	310	430	300	36	4.5	1395	1935	6.00	47	310	350	325	39	4.9	1520	1715	5.51
1½	8	38	300	490	280	34	4.3	1290	2105	6.28	43	305	405	305	37	4.6	1405	1865	5.87
2	8	35	300	560	270	32	4.0	1200	2240	6.75	40	305	455	295	35	4.4	1340	2000	6.14
With Medium Sand—Fineness Modulus 2.60-2.90†																			
¾	5	43	180	235	310	37	7.4	1330	1740	3.65	48	175	190	335	40	8.0	1400	1520	3.38
1	5	38	165	270	300	36	7.2	1190	1945	3.75	43	165	220	325	39	7.8	1290	1715	3.46
1½	5	34	160	310	280	34	6.8	1090	2110	3.97	39	160	250	305	37	7.4	1185	1850	3.65
2	5	31	160	350	270	32	6.4	1025	2240	4.22	36	160	290	295	35	7.0	1120	2030	3.86
¾	5½	44	205	260	310	37	6.7	1370	1740	4.03	49	200	210	335	40	7.3	1460	1535	3.70
1	5½	39	190	300	300	36	6.5	1235	1950	4.15	44	190	240	325	39	7.1	1350	1705	3.80
1½	5½	35	180	340	280	34	6.2	1115	2115	4.36	40	185	280	305	37	6.7	1240	1875	4.03
2	5½	32	180	390	270	32	5.8	1045	2260	4.66	37	185	315	295	35	6.4	1185	2015	4.22
¾	6	45	230	280	310	37	6.2	1425	1735	4.36	50	230	230	335	40	6.7	1540	1540	4.03
1	6	40	215	320	300	36	6.0	1290	1920	4.50	45	215	260	325	39	6.5	1400	1690	4.15
1½	6	36	205	365	280	34	5.7	1170	2080	4.74	41	210	300	305	37	6.2	1300	1860	4.36
2	6	33	210	425	270	32	5.3	1110	2250	5.10	38	210	345	295	35	5.8	1220	2000	4.66
¾	6½	46	260	305	310	37	5.7	1480	1740	4.74	51	255	245	335	40	6.2	1580	1520	4.36
1	6½	41	240	350	300	36	5.5	1320	1925	4.91	46	240	280	325	39	6.0	1440	1680	4.50
1½	6½	37	235	400	280	34	5.2	1220	2080	5.19	42	235	325	305	37	5.7	1340	1850	4.74
2	6½	34	235	455	270	32	4.9	1150	2230	5.51	39	235	370	295	35	5.4	1270	2000	5.00
¾	7	47	285	325	310	37	5.3	1510	1725	5.10	52	285	265	335	40	5.7	1625	1510	4.74
1	7	42	270	370	300	36	5.1	1375	1890	5.30	47	265	300	325	39	5.6	1480	1680	4.82
1½	7	38	260	420	280	34	4.9	1275	2060	5.51	43	260	350	305	37	5.3	1380	1855	5.10
2	7	35	260	480	270	32	4.6	1195	2210	5.87	40	265	395	295	35	5.0	1325	1975	5.40
¾	7½	48	320	350	310	37	4.9	1570	1715	5.51	53	315	280	335	40	5.3	1670	1485	5.10
1	7½	43	295	390	300	36	4.8	1415	1875	5.63	48	295	320	325	39	5.2	1535	1665	5.19
1½	7½	39	290	455	280	34	4.5	1305	2050	6.00	44	295	370	305	37	4.9	1445	1810	5.51
2	7½	36	285	510	270	32	4.3	1225	2190	6.28	41	290	415	295	35	4.7	1360	1950	5.75
¾	8	49	350	365	310	37	4.6	1610	1680	5.87	54	345	290	335	40	5.0	1725	1450	5.40
1	8	44	325	415	300	36	4.5	1465	1870	6.00	49	320	335	325	39	4.9	1570	1640	5.51
1½	8	40	315	470	280	34	4.3	1355	2020	6.28	45	320	395	305	37	4.6	1470	1820	5.87
2	8	37	320	540	270	32	4.0	1280	2160	6.75	42	320	440	295	35	4.4	1410	1935	6.14
With Coarse Sand—Fineness Modulus 2.90-3.20†																			
¾	5	45	185	230	310	37	7.4	1370	1700	3.65	50	185	185	335	40	8.0	1480	1480	3.38
1	5	40	175	260	300	36	7.2	1260	1870	3.75	45	170	210	325	39	7.8	1325	1640	3.46
1½	5	36	170	300	280	34	6.8	1155	2040	3.97	41	170	245	305	37	7.4	1260	1810	3.65
2	5	33	170	340	270	32	6.4	1090	2175	4.22	38	170	280	295	35	7.0	1190	1960	3.86
¾	5½	46	215	250	310	37	6.7	1440	1675	4.03	51	210	200	335	40	7.3	1535	1460	3.70
1	5½	41	200	285	300	36	6.5	1300	1855	4.15	46	195	230	325	39	7.1	1385	1635	3.80
1½	5½	37	190	330	280	34	6.2	1180	2045	4.36	42	195	270	305	37	6.7	1310	1810	4.03
2	5½	34	195	375	270	32	5.8	1130	2175	4.66	39	195	305	295	35	6.4	1250	1950	4.22
¾	6	47	240	270	310	37	6.2	1490	1675	4.36	52	235	220	335	40	6.7	1575	1475	4.03
1	6	42	225	310	300	36	6.0	1350	1860	4.50	47	225	250	325	39	6.5	1460	1625	4.15
1½	6	38	220	355	280	34	5.7	1250	2020	4.74	43	220	290	305	37	6.2	1360	1800	4.36
2	6	35	220	410	270	32	5.3	1165	2170	5.10	40	220	335	295	35	5.8	1280	1940	4.66
¾	6½	48	270	290	310	37	5.7	1540	1650	4.74	53	265	235	335	40	6.2	1640	1460	4.36
1	6½	43	255	335	300	36	5.5	1400	1840	4.91	48	250	270	325	39	6.0	1500	1620	4.50
1½	6½	39	250	390	280	34	5.2	1300	2030	5.19	44	245	315	305	37	5.7	1400	1795	4.74
2	6½	36	250	440	270	32	4.9	1225	2160	5.51	41	250	355	295	35	5.4	1350	1920	5.00
¾	7	49	300	310	310	37	5.3	1590	1640	5.10	54	295	250	335	40	5.7	1680	1425	4.74
1	7	44	280	360	300	36	5.1	1430	1835	5.30	49	275	290	325	39	5.6	1540	1625	4.82
1½	7	40	270	405	280	34	4.9	1320	1985	5.51	45	275	335	305	37	5.3	1455	1775	5.10
2	7	37	270	465	270	32	4.6	1240	2140	5.87	42	280	380	295	35	5.0	1400	1900	5.40
¾	7½	50	335	335	310	37	4.9	1640	1640	5.51	55	330	270	335	40	5.3	1750	1430	5.10
1	7½	45	310	375	300	36	4.8	1490	1800	5.63	50	305	305	325	39	5.2	1585	1585	5.19
1½	7½	41	305	440	280	34	4.5	1375	1980	6.00	46	310	360	305	37	4.9	1520	1765	5.51
2	7½	38	300	495	270	32	4.3	1290	2130	6.28	43	305	400	295	35	4.7	1430	1880	5.75
¾	8	51	365	350	310	37	4.6	1680	1610	5.87	56	355	280	335	40	5.0	1775	1400	5.40
1	8	46	340	400	300	36	4.5	1530	1800	6.00	51	335	320	325	39	4.9	1640	1570	5.51
1½	8	42	330	455	280	34	4.3	1420	1960	6.28	47	335	380	305	37	4.6	1540	1750	5.87
2	8	39	335	525	270	32	4.0	1340	2100	6.75	44	335	425	295	35	4.4	1475	1870	6.14

*Increase or decrease water content 3 per cent for each increase or decrease of 1 in. in slump. For stone sand; increase percentage of sand by about 3 and water content by about 15 lb. per cu.yd. of concrete.
†Fineness modulus of an aggregate is the sum of the percentages given by the sieve analysis, divided by 100. The sieve analysis is expressed as percentages of the material by volume or weight retained on the following sieves from the Tyler standard series: 100, 48, 28, 14, 8, 4, ⅜-in., ¾-in. and 1½-in. Majority of natural sands used for concrete have medium grading.

CONVERSION FACTORS

(Continued)

Multiply	By	To Obtain
Pounds of water	0.01602	Cubic feet
" " "	27.68	Cubic inches
" " "	0.1198	Gallons
Pounds/cubic foot	0.01602	Grams/cubic cm.
" " "	16.02	Kgs./cubic meter
" " "	5.787×10^{-4}	Lbs./cubic inch
Pounds/foot	1.488	Kgs./meter
Pounds/inch	178.6	Grams/cm.
Pounds/sq. foot	0.01602	Feet of water
" " "	4.883	Kgs./sq. meter
Pounds/sq. inch	2.307	Feet of water
" " "	2.036	Inches of mercury
" " "	0.06804	Atmospheres
" " "	703.1	Kgs./sq. meter
Quires	25	Sheets
Reams	500	Sheets
Square centimeters	0.1550	Square inches
" "	1.076×10^{-8}	Square feet
Square feet	144	Square inches
" "	0.09290	Square meters
" "	2.296×10^{-5}	Acres
Square inches	6.452	Square centimeters

Multiply	By	To Obtain
Squaré kilometers	247.1	Acres
" "	10.76×10^{6}	Square feet
" "	1.196×10^{6}	Square yards
Square meters	10.76	Square feet
" "	1.196	Square yards
Square miles	640	Acres
" "	27.88×10^{6}	Square feet
" "	2.590	Square Kilometers
Square yards	9	Square feet
" "	0.8361	Square meters
" "	2.066×10^{-4}	Acres
Tons (long)	1016	Kilograms
" "	2240	Pounds
" "	1.12000	Tons (short)
Tons (metric)	10^{3}	Kilograms
" "	2205	Pounds
Tons (short)	2000	Pounds
" "	907.18486	Kilograms
Tons of water/24 hrs.	0.16643	Gallons/min.
Watts	0.05692	B.T.Units/min.
"	0.7376	Foot-pounds/sec
"	1.341×10^{-3}	Horse-power
"	0.01434	Kg.-calories/min
Yards	0.9144	Meters

TEMPERATURE CONVERSION TABLE
CENTIGRADE AND FAHRENHEIT

From the "Barrett Road Book," published by The Barrett Company

C°	F°	C°	F°	C°	F°	C°	F°	C°	F°	C°	F°	C°	F°	C°	F°
0	32	45	113	91	195.8	137	278.6	183	361.4	217	422.6	248.9	480	282.22	540
1	33.8	46	114.8	92	197.6	138	280.4	184	363.2	218	424.4	249	480.2	283	541.4
2	35.6	47	116.6	93	199.4	139	282.2	185	365	218.3	425	250	482	284	543.2
3	37.4	48	118.4	94	201.2	140	284	186	366.8	219	426.2	251	483.8	285	545
4	39.2	49	120.2	95	203	141	285.8	187	368.6	220	428	252	485.6	286	546.8
5	41	50	122	96	204.8	142	287.6	188	370.4	221	429.8	253	487.4	287	548.6
6	42.8	51	123.8	97	206.6	143	289.4	189	372.2	222	431.6	254	489.2	288	550.4
7	44.6	52	125.6	98	208.4	144	291.2	190	374	223	433.4	255	491	289	552.2
8	46.4	53	127.4	99	210.2	145	293	191	375.8	224	435.2	256	492.8	290	554
9	48.2	54	129.2	100	212	146	294.8	192	377.6	225	437	257	494.6	291	555.8
10	50	55	131	101	213.8	147	296.6	193	379.4	226	438.8	258	496.4	292	557.6
11	51.8	56	132.8	102	215.6	148	298.4	194	381.2	227	440.6	259	498.2	293	559.4
12	53.6	57	134.6	103	217.4	149	300.2	195	383	228	442.4	260	500	294	561.2
13	55.4	58	136.4	104	219.2	150	302	196	384.8	229	444.2	261	501.8	295	563
14	57.2	59	138.2	105	221	151	303.8	197	386.6	230	446	262	503.6	296	564.8
15	59	60	140	106	222.8	152	305.6	198	388.4	231	447.8	263	505.4	297	566.6
15.5	60	61	141.8	107	224.6	153	307.4	199	390.2	232	449.6	264	507.2	298	568.4
16	60.8	62	143.6	108	226.4	154	309.2	200	392	232.2	450	265	509	299	570.2
17	62.6	63	145.4	109	228.2	155	311	201	393.8	233	451.4	266	510.8	300	572
18	64.4	64	147.2	110	230	156	312.8	202	395.6	234	453.2	267	512.6	301	573.8
19	66.2	65	149	111	231.8	157	314.6	203	397.4	235	455	268	514.4	302	575.6
20	68	66	150.8	112	233.6	158	316.4	204	399.2	236	456.8	269	516.2	303	577.4
21	69.8	67	152.6	113	235.4	159	318.2	204.4	400	237	458.6	270	518	304	579.2
22	71.6	68	154.4	114	237.2	160	320	205	401	238	460.4	271	519.8	305	581
23	73.4	69	156.2	115	239	161	321.8	206	402.8	239	462.2	272	521.6	306	582.8
24	75.2	70	158	116	240.8	162	323.6	207	404.6	240	464	273	523.4	307	584.6
25	77	71	159.8	117	242.6	163	325.4	208	406.4	241	465.8	274	525.2	308	586.4
26	78.8	72	161.6	118	244.4	164	327.2	209	408.2	242	467.6	275	527	309	588.2
27	80.6	73	163.4	119	246.2	165	329	210	410	243	469.4	276	528.8	310	590
28	82.4	74	165.2	120	248	166	330.8	211	411.8	244	471.2	277	530.6	311	591.8
29	84.2	75	167	121	249.8	167	332.6	212	413.6	245	473	278	532.4	312	593.6
30	86	76	168.8	122	251.6	168	334.4	213	415.4	246	474.8	279	534.2	313	595.4
31	87.8	77	170.6	123	253.4	169	336.2	214	417.2	246.1	475	280	536	314	597.2
32	89.6	78	172.4	124	255.2	170	338	215	419	247	476.6	281	537.8	315	599
33	91.4	79	174.2	125	257	171	339.8	216	420.8	248	478.4	282	539.6		
34	93.2	80	176	126	258.8	172	341.6								
35	95	81	177.8	127	260.6	173	343.4								
36	96.8	82	179.6	128	262.4	174	345.2								
37	98.6	83	181.4	129	264.2	175	347								
38	100.4	84	183.2	130	266	176	348.8								
39	102.2	85	185	131	267.8	177	350.6								
40	104	86	186.8	132	269.6	178	352.4								
41	105.8	87	188.6	133	271.4	179	354.2								
42	107.6	88	190.4	134	273.2	180	356.2								
43	109.4	89	192.2	135	275	181	357.8								
44	111.2	90	194	136	276.8	182	359.6								

Temperature F. equals 1.8 C. plus 32.

Temperature C. equals F. minus 32, divided by 1.8.

CONVERSION FACTORS*

Courtesy of Water and Sewage Works

The word gallon, used in any conversion factor, designates the U. S. gallon. Likewise, the word ton designates a short ton, 2,000 pounds.

The figures 10^{-1}, 10^{-2}, 10^{-3}, etc., denote 0.1, 0.01, 0.001, etc., respectively.

The figures 10^{1}, 10^{2}, 10^{3}, etc., denote 10, 100, 1000, etc., respectively.

"Parts Per Million," (designated as p.p.m.), is always by weight. As used in the sanitary field, p.p.m. represents the number of pounds of dry solids contained in one million pounds of water. In this field, one part per million may be expressed as 8.345 pounds of dry solids to one million U. S. gallons of water.

Multiply	By	To Obtain
Acres	43,560	Square feet
"	4047	Square meters
Acre-feet	43,560	Cubic feet
" "	325,851	Gallons
" "	1233.49	Cubic meters
Atmospheres	29.92	Inches of mercury
"	33.90	Feet of water
"	76.0	Cms. of mercury
"	14.70	Lbs./sq. inch
Barrels cement	376	Pounds—cement
Bags or sacks-cement	94	Pounds— "
British Thermal Units	777.5	Foot-lbs.
" " "	3.927×10^{-4}	Horse-power-hrs.
" " "	2.928×10^{-4}	Kilowatt-hrs.
" " "	0.2520	Kilogram-calories
" " "	107.5	Kilogram-meters
B.T.U./min.	12.96	Foot-lbs./sec.
" "	0.02356	Horse-power
" "	0.01757	Kilowatts
Centimeters	0.3937	Inches
Centimeters of mercury	0.01316	Atmospheres
" " "	0.4461	Feet of water
" " "	27.85	Lbs./sq. ft.
" " "	0.1934	Lbs./sq. inch
Centimeters/second	1.969	Feet/min.
" "	0.03281	Feet/sec.
" "	0.6	Meters/min.
Cubic centimeters	3.531×10^{-5}	Cubic feet
" "	6.102×10^{-2}	Cubic inches
" "	2.642×10^{-4}	Gallons
" "	10^{-6}	Cubic meters
" "	10^{-3}	Liters
Cubic feet	7.48052	Gallons
" "	1728	Cubic inches
" "	0.03704	Cubic yards
" "	28.32	Liters
" "	2.832×10^{4}	Cubic cms.
" "	0.02832	Cubic meters
Cubic feet/second	0.646317	Million gals./day
" " "	448.831	Gallons/min.
Cubic inches	16.39	Cubic centimeters
" "	5.787×10^{-4}	Cubic feet
" "	1.639×10^{-5}	Cubic meters
" "	4.329×10^{-3}	Gallons
" "	1.639×10^{-2}	Liters
Cubic meters	35.31	Cubic feet
" "	1.308	Cubic yards
" "	264.2	Gallons
" "	10^{3}	Liters
Cubic yards	27	Cubic feet
" "	46.656	Cubic inches
" "	0.7646	Cubic meters
" "	202.0	Gallons
" "	764.6	Liters
Drams	27.34375	Grains
"	0.0625	Ounces
"	1.771845	Grams
Fathoms	6	Feet
Feet	30.48	Centimeters
"	0.3048	Meters
Feet of water	0.8826	Inches of mercury
" " "	0.4335	Lbs./sq. inch
" " "	62.43	Lbs./sq. ft.
" " "	0.02950	Atmospheres
" " "	304.8	Kgs./sq. meter
Feet/sec.	30.48	Centimeters/sec.
" "	18.29	Meters/min.
Foot-pounds	1.286×10^{-3}	British thermal units
" "	5.050×10^{-7}	Horse-power-hrs.
" "	0.1383	Kilogram-meters
" "	3.766×10^{-7}	Kilowatt-hrs.
Foot-pounds/min.	3.030×10^{-5}	Horse-power
" " "	2.260×10^{-5}	Kilowatts
Gallons	0.1337	Cubic feet
"	231	Cubic inches
"	3785	Cubic centimeters
"	3.785×10^{-3}	Cubic meters
"	3.785	Liters
Gallons, Imperial	1.200095	U. S. gallons
" U. S.	0.83267	Imperial gallons
Gallons water	8.3453	Pounds of water
Gallons/min.	2.228×10^{-3}	Cubic feet/sec.
" "	0.06308	Liters/sec.
" "	8.0208	Cu. ft./hr.
Grains (troy)	1	Grains (avoir.)
"	0.06480	Grams
Grains/U.S. gal.	17.118	Parts/million
" /U.S. gal.	142.86	Lbs./million gal.
" /Imp. gal.	14.254	Parts/million
Grams	15.43	Grains
"	0.03527	Ounces
"	980.7	Dynes
Grams/liter	58.417	Grains/gal.
" "	8.345	Pounds/1000 gals.
" "	1000	Parts/million
Hectares	2.471	Acres
Horse-power	42.44	B.T. Units/min.
" "	550	Foot-lbs./sec.
" "	0.7457	Kilowatts
Horse-power (boiler)	33,479	B.T.U./hr.
" " "	9.803	Kilowatts
Inches	2.540	Centimeters
Inches of mercury	1.133	Feet of water
" " "	0.4912	Lbs./sq. inch
" " "	0.03342	Atmospheres
" " "	345.3	Kgs./sq. meter
Inches of water	0.07355	Inches of mercury
" " "	0.03613	Lbs./sq. inch
Kilograms	2.205	Lbs.
Kilograms-calories/min.	51.43	Foot-pounds/sec.
" " "	0.09351	Horse-power
" " "	0.06972	Kilowatts
Kgs./sq. meter	3.281×10^{-3}	Feet of water
" " "	1.422×10^{-3}	Lbs./sq. inch
Kilometers	3281	Feet
"	0.6214	Miles
Kilometers/hr.	0.9113	Feet/sec.
" "	27.78	Centimeters/sec.
Kilowatts	56.92	B.T. Units/min.
"	737.6	Foot-lbs./sec.
"	1.341	Horse-power
"	14.34	Kg.-calories/min.
Liters	0.2642	Gallons
"	61.02	Cubic inches
"	0.03531	Cubic feet
Meters	3.281	Feet
"	39.37	Inches
"	1.094	Yards
Miles	5280	Feet
"	1.609	Kilometers
Miles/min.	88	Feet/sec.
" "	1.609	Kilometers/min.
Milligrams/liter	1	Parts/million
Million gals./day	1.54723	Cubic ft./sec.
Miner's inches	1.5	Cubic ft./min.
Ounces	28.349527	Grams
"	437.5	Grains
"	0.9115	Ounces (troy)
Ounces (fluid)	1.805	Cubic inches
" "	29.57	Cubic cm.
Parts/million	8.345	Lbs./million gal.
" "	0.0584	Grains/U. S. gal.
" "	0.07016	Grains/Imp. gal.
Pounds	16	Ounces
"	7000	Grains
"	453.5924	Grams
"	1.21528	Pounds (troy)

*Selections from a booklet of—"Conversion Factors for Engineers"—distributed by The Dorr Co., New York City.

HOW TO FIND THE LENGTH OF A BELT

Courtesy of Pioneer Engineering Company
Minneapolis, Minnesota

1. Add the diameter of the 2 pulleys together.
2. Multiply this sum by 1.57.
3. Add twice the distance between the centers of shafts. This will give the exact length of the belt if the pulleys are of the same size. If there is considerable difference in the sizes of the 2 pulleys, the additional length of belt required can be figured as follows:
4. Subtract the diameter of the smaller pulley from the diameter of the larger pulley.
5. Multiply the remainder by itself.
6. Divide this product by 4 times the distance between the centers of shafts.
7. The result added to the figure obtained before will give the exact length of belt required.

EXAMPLE:

What length of belt will be required to pass over 2 pulleys —one of 2′ diameter and the other 5′ diameter—the distance between shaft centers being 20′?

	5	ft. dia. large pulley
1.	+ 2	ft. dia. small pulley
	7	ft. sum of diameters
2.	× 1.57	(constant)
	10.99	ft.
3.	+ 40.00	(twice distance between centers)
	50.99	length of belt or 51 ft.
	5	ft. dia. large pulley
4.	— 2	ft. dia. small pulley
	3	ft. difference of diameters
5.	× 3	(Multiplied by itself)
	9	
6.	÷ 80	(divided by 4 times distance between shaft centers)
	11.25	
7.	+ 50.99	length of belt
	51.10	ft. length of belt or 51 ft. 1 1/5 in.

DETERMINING YARDAGE ON REELS OR DRUMS

Although the formula was designed for computing the length of cable, etc., of various diameters, which a reel or drum of given dimensions will accommodate, the method is equally valuable for determining footage remaining on a reel or drum, for inventory purposes or other reasons. In such instances the depth (A) is the depth (in inches) of rope, cable, wire, etc., remaining on the drum or reel.

Example: Assume a reel having a 5 in. core (B) and a width of 10 in. (C). The material is ¼ in. in diameter and its depth on the core is 2 in. (A).

$$(B + A) \times A \times C = X$$
$$(5 + 2) \times 2 \times 10 = 140$$

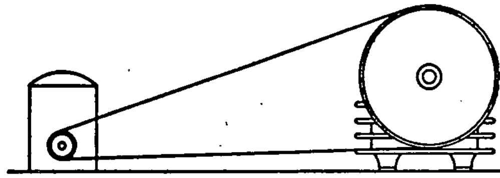
Now refer to table of factors for the "K" value for ¼ in. materials, such being 4.16 ∴ The footage is 140 × 4.16 = 582 ft. or, if ½ in. material 140 × 1.05 = 147 ft.

If it is desired to determine the length of rope, wire, rubber hose, copper tubing, packing, caulking yarn, etc., wound on a drum or reel, the accompanying formula will prove very helpful.

The sketch, with formula and factors, appeared in Wire Rope Cat. No. 20 of the Hazard Wire Rope Div. of American Chain and Cable Co. Inc.

PULLEY DIAMETERS OF POWER UNITS, CRUSHERS AND SCREENS

Courtesy of Pioneer Engineering Company
Minneapolis, Minnesota



When you want to find the correct size of pulley for the power unit, use the following—

FIRST: You must have the following information:

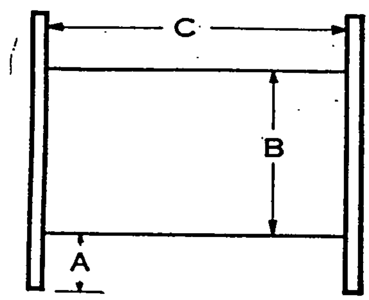
	EXAMPLE
1. R. P. M. of Crusher	250
2. Diameter of Crusher flywheel	50″
3. R. P. M. of motor	950

SECOND: Method:

1. Multiply the R. P. M. of the crusher	250
2. By the diameter of the flywheel	50″
	12500
3. Divide the answer by the R. P. M. of the motor	950
The answer is the diameter of the motor pulley in inches	13″

The same formula can be used to determine the size of the pulley to be used on a screen—

	EXAMPLE
1. Multiply the R. P. M. of the motor	975
2. By the diameter of the motor pulley	8″
	7800
3. Divide by the speed of the screen	260
Diameter of the screen pulley	30″



FORMULA:— $L = (A + B) \times A \times C \times K$

L = Length of rope in feet.
A = Depth of flange in inches. In computing capacity of reels "A" is reduced 1½″ to 2″ to provide for a clearance.
B = Diameter of drum in inches.
C = Width of drum in inches.
K = Constant which is given below for a given size of rope.

Rope Dia.	Value of "K"	Rope Dia.	Value of "K"
1/32	266.24	7/8	.342
1/16	66.56	1	.262
3/32	29.76	1 1/8	.207
1/8	16.64	1 1/4	.167
5/32	10.76	1 3/8	.138
3/16	7.44	1 1/2	.116
1/4	4.16	1 5/8	.099
5/16	2.67	1 3/4	.085
3/8	1.86	1 7/8	.074
7/16	1.37	2	.066
1/2	1.05	2 1/8	.058
9/16	.828	2 1/4	.052
5/8	.672	2 3/8	.046
3/4	.465	2 1/2	.042

AREAS OF CIRCLES—SQUARES—SQUARE ROOTS

(Also Fractions to Decimal Equivalent.)

No. N Fraction	No. N Decimal	N²	√N	Area Circle (N = Diam.)
1/16	.0625	.0039	.2500	.0031
⅛	.125	.0156	.3536	.0125
3/16	.1875	.0352	.4330	.0276
¼	.25	.0625	.5000	.0491
5/16	.3125	.0977	.5590	.0767
⅜	.375	.1406	.6124	.1105
7/16	.4375	.1914	.6614	.1503
½	.50	.2500	.7071	.1964
9/16	.5625	.3164	.7500	.2485
⅝	.625	.3906	.7906	.3068
11/16	.6875	.4727	.8297	.3712
¾	.75	.5625	.8660	.4418
13/16	.8125	.6602	.9014	.5185
⅞	.875	.7656	.9354	.6013
15/16	.9375	.8789	.9683	.6903
1	1.	1.000	1.000	.7854
1⅛	1.125	1.266	1.061	.9940
1¼	1.25	1.563	1.118	1.227
1⅜	1.375	1.891	1.175	1.485
1½	1.50	2.250	1.225	1.767
1⅝	1.625	2.641	1.275	2.074
1¾	1.75	3.063	1.323	2.405
1⅞	1.875	3.516	1.369	2.761
2	2.	4.000	1.414	3.142
2⅛	2.125	4.516	1.458	3.547
2¼	2.25	5.063	1.500	3.976
2⅜	2.375	5.641	1.541	4.430
2½	2.50	6.250	1.581	4.909
2⅝	2.625	6.891	1.620	5.412
2¾	2.75	7.563	1.658	5.940
2⅞	2.875	8.266	1.696	6.492
3	3.	9.000	1.732	7.069
3⅛	3.125	9.766	1.768	7.670
3¼	3.25	10.56	1.803	8.296
3⅜	3.375	11.39	1.837	8.946
3½	3.50	12.25	1.871	9.621
3⅝	3.625	13.14	1.904	10.32
3¾	3.75	14.06	1.937	11.04
3⅞	3.875	15.02	1.969	11.79
4	4.	16.00	2.000	12.57
4⅛	4.125	17.02	2.031	13.36
4¼	4.25	18.06	2.062	14.19
4⅜	4.375	19.14	2.092	15.03
4½	4.50	20.25	2.121	15.90
4⅝	4.625	21.39	2.151	16.80
4¾	4.73	22.56	2.180	17.72
4⅞	4.875	23.77	2.208	18.67
5	5.00	25.00	2.236	19.64
5¼	5.25	27.56	2.291	21.65
5½	5.50	30.25	2.345	23.76
5¾	5.75	33.06	2.398	25.97
6	6.	36.00	2.450	28.27
6¼	6.25	39.06	2.500	30.68
6½	6.50	42.25	2.550	33.18
6¾	6.75	45.56	2.598	35.78
7	7.	49.00	2.646	38.48
7¼	7.25	52.56	2.693	41.28
7½	7.50	56.25	2.739	44.18
7¾	7.75	60.06	2.784	47.17
8	8.00	64.00	2.828	50.27
8¼	8.25	68.06	2.872	53.46
8½	8.50	72.25	2.916	56.75
8¾	8.75	76.56	2.958	60.13
9	9.00	81.00	3.000	63.62
9¼	9.25	85.56	3.041	67.20
9½	9.50	90.25	3.082	70.88
9¾	9.75	95.06	3.123	74.66

No. N	N²	√N	Area Circle (N = Diam.)
10	100	3.162	78.54
11	121	3.317	95.03
12	144	3.464	113.1
13	169	3.606	132.7
14	196	3.742	153.9
15	225	3.873	176.7
16	256	4.000	201.1
17	289	4.123	227.0
18	324	4.243	254.5
19	361	4.359	283.5
20	400	4.472	314.2
21	441	4.583	346.4
22	484	4.690	380.1
23	529	4.796	415.5
24	576	4.899	452.4
25	625	5.000	490.9
26	676	5.099	530.9
27	729	5.196	572.6
28	784	5.292	615.8
29	841	5.385	660.5
30	900	5.477	706.9
31	961	5.568	754.8
32	1024	5.657	804.2
33	1089	5.745	855.3
34	1156	5.831	907.9
35	1225	5.916	962.1
36	1296	6.000	1017.9
37	1369	6.083	1075.2
38	1444	6.164	1134.1
39	1521	6.245	1194.6
40	1600	6.325	1256.7
41	1681	6.403	1320.3
42	1764	6.481	1385.4
43	1849	6.557	1452.2
44	1936	6.633	1520.5
45	2025	6.708	1590.4
46	2116	6.782	1661.9
47	2209	6.856	1734.9
48	2304	6.928	1809.6
49	2401	7.000	1885.7
50	2500	7.071	1936.5
51	2601	7.141	2042.8
52	2704	7.211	2123.7
53	2809	7.280	2206.2
54	2916	7.349	2290.2
55	3025	7.416	2375.8
56	3136	7.483	2463.0
57	3249	7.500	2551.8
58	3364	7.616	2642.1
59	3481	7.681	2734.0
60	3600	7.746	2827.4
61	3721	7.810	2922.5
62	3844	7.874	3019.1
63	3969	7.937	3117.2
64	4096	8.000	3217.0
65	4225	8.062	3318.3
66	4356	8.124	3421.2
67	4489	8.185	3525.7
68	4624	8.246	3631.7
69	4761	8.307	3739.3
70	4900	8.367	3848.5
71	5041	8.426	3959.2
72	5184	8.485	4071.5
73	5329	8.544	4185.4
74	5476	8.602	4300.8
75	5625	8.660	4417.9

No. N	N²	√N	Area Circle (N = Diam.)
76	5776	8.718	4536.5
77	5929	8.775	4656.6
78	6084	8.832	4778.4
79	6241	8.888	4901.7
80	6400	8.944	5026.5
81	6561	9.000	5153.0
82	6724	9.055	5281.0
83	6889	9.110	5410.6
84	7056	9.165	5541.8
85	7225	9.220	5674.5
86	7396	9.274	5808.8
87	7569	9.327	5944.7
88	7744	9.381	6082.1
89	7921	9.434	6221.1
90	8100	9.487	6361.7
91	8281	9.539	6503.9
92	8464	9.592	6647.6
93	8649	9.644	6792.9
94	8836	9.695	6939.8
95	9025	9.747	7088.2
96	9216	9.798	7238.2
97	9409	9.849	7389.8
98	9604	9.900	7543.0
99	9801	9.950	7697.7
100	10000	10.00	7854.0
101	10201	10.05	8011.9
102	10404	10.10	8171.3
103	10609	10.15	8332.3
104	10816	10.20	8494.9
105	11025	10.25	8659.0
106	11236	10.30	8824.7
107	11449	10.34	8992.0
108	11664	10.39	9160.9
109	11881	10.44	9331.3
110	12100	10.49	9503.3
111	12321	10.54	9676.9
112	12544	10.58	9852.0
113	12769	10.63	10029
114	12996	10.68	10207
115	13225	10.72	10387
116	13456	10.77	10568
117	13689	10.82	10751
118	13924	10.86	10936
119	14161	10.91	11122
120	14400	10.95	11310
121	14641	11.00	11499
122	14884	11.05	11690
123	15129	11.09	11882
124	15376	11.14	12076
125	15625	11.18	12272
126	15876	11.23	12469
127	16129	11.27	12668
128	16384	11.31	12868
129	16641	11.36	13070
130	16900	11.40	13273
131	17161	11.45	13478
132	17424	11.49	13685
133	17689	11.53	13893
134	17956	11.58	14103
135	18225	11.62	14314
136	18496	11.66	14527
137	18769	11.70	14741
138	19044	11.75	14957
139	19321	11.79	15175
140	19600	11.83	15394
141	19881	11.87	15615

No. N	N²	√N	Area Circle (N = Diam.)
142	20164	11.92	15837
143	20449	11.96	16061
144	20736	12.00	16286
145	21025	12.04	16583
146	21316	12.08	16742
147	21609	12.12	16972
148	21904	12.17	17203
149	22201	12.22	17437
150	22500	12.25	17671
151	22801	12.29	17908
152	23104	12.33	18146
153	23409	12.37	18385
154	23716	12.41	18627
155	24025	12.45	18869
156	24336	12.49	19113
157	24649	12.53	19359
158	24964	12.57	19607
159	25281	12.61	19856
160	25600	12.65	20106
161	25921	12.69	20358
162	26244	12.73	20613
163	26569	12.77	20867
164	26896	12.81	21124
165	27225	12.85	21382
166	27556	12.88	21642
167	27889	12.92	21904
168	28224	12.96	22168
169	28561	13.00	22432
170	28900	13.04	22698
171	29241	13.08	22966
172	29584	13.11	23235
173	29929	13.15	23506
174	30276	13.19	23779
175	30625	13.23	24053
176	30976	13.27	24328
177	31329	13.30	24606
178	31684	13.34	24885
179	32041	13.38	25165
180	32400	13.42	25447
181	32761	13.45	25730
182	33124	13.49	26016
183	33489	13.53	26302
184	33856	13.56	26590
185	34225	13.60	26880
186	34596	13.64	27172
187	34969	13.67	27465
188	35344	13.71	27759
189	35721	13.75	28055
190	36100	13.78	28353
191	36481	13.82	28652
192	36864	13.86	28953
193	37249	13.89	29255
194	37636	13.93	29559
195	38025	13.96	29865
196	38416	14.00	30172
197	38809	14.04	30481
198	39204	14.07	30791
199	39601	14.11	31103
200	40000	14.14	31416
...	.....	....	.....
...	.....	....	.....
...	.....	....	.....
...	.....	....	.....
...	.....	....	.....
...	.....	....	.....
...	.....	....	.....

FLOWING WATER RATES AND EQUIVALENTS

Second Feet, Miners Inches, Acre Feet, Gallons per Minute, Cubic Meters per Minute, etc.

From Handbook of Culvert and Drainage Practice of Armco Culvert Manufacturers Association, Middletown, Ohio

C.F.S. = cubic feet per second, or second feet

G.P.M. = gallons per minute

1 C.F.S. = 60 cu. ft. per min.

= 86,400 cu. ft. per 24 hrs.

= 448.83 U. S. gals. per min.

= 646,317 U. S. gals. per 24 hrs.

= 1.9835 acre-foot per 24 hrs. (usually taken as 2)

= 1 acre-inch per hour (approximate)

= .028317 cu. meters per second

= 2446.59 cu. meters per day

= 50 miners inches, Idaho, Kan., Neb., New Mex., N. Dak., S. Dak.

= 40 miners inches, Ariz., Calif., Mont. and Oregon

= 38.4 miners inches, Colorado

= 36 miners inches, British Columbia

1 inch depth per hour = 645.33 C.F.S. per sq. mi.

1 inch depth per day = 26.889 C.F.S. per sq. mi.

1 acre-inch per hour = 1.0083 C.F.S. (usually taken as unity)

1 U.S.G.P.M. = 1440 U. S. gals. per 24 hrs.
= 0.00442 acre-feet per 24 hrs.
= 0.0891 miners inches, Ariz., Calif.

1 million U. S. gal. per day = 1.5472 C.F.S.
= 3.07 acre-feet
= 2.629 cu. meters per min.

WATER PRESSURES AND HEADS

Static heads in feet and corresponding pressures of water in pounds per square inch at 62° F.

Feet Head	Pressure per sq. in.	Feet Head	Pressure per sq. in.	Feet Head	Pressure per sq. in.	Feet Head	Pressure per sq. in.	Feet Head	Pressure per sq. in.	Feet Head	Pressure per sq. in.
1	0.43	54	23.39	107	46.34	160	69.31	213	92.20	285	123.45
2	0.86	55	23.82	108	46.78	161	69.74	214	92.69	290	125.62
3	1.30	56	24.26	109	47.21	162	70.17	215	93.13	295	127.78
4	1.73	57	24.69	110	47.64	163	70.61	216	93.56	300	129.95
5	2.16	58	25.12	111	48.08	164	71.04	217	92.99	305	132.12
6	2.59	59	25.55	112	48.51	165	71.47	218	94.43	310	134.28
7	3.03	60	25.99	113	48.94	166	71.91	219	94.86	315	136.46
8	3.46	61	26.42	114	49.38	167	72.34	220	95.30	320	138.62
9	3.89	62	26.85	115	49.81	168	72.77	221	95.73	325	140.79
10	4.33	63	27.29	116	50.24	169	73.20	222	96.16	330	142.95
11	4.76	64	27.72	117	50.68	170	73.64	223	96.60	335	145.12
12	5.20	65	28.15	118	51.11	171	74.07	224	97.03	340	147.28
13	5.63	66	28.58	119	51.54	172	74.50	225	97.46	345	149.45
14	6.06	67	29.02	120	51.98	173	74.94	226	97.90	350	151.61
15	6.49	68	29.45	121	52.41	174	75.37	227	98.33	355	153.78
16	6.93	69	29.88	122	52.84	175	75.80	228	98.76	360	155.94
17	7.36	70	30.32	123	53.28	176	76.23	229	99.20	365	158.10
18	7.79	71	30.75	124	53.71	177	76.67	230	99.63	370	160.27
19	8.22	72	31.18	125	54.15	178	77.10	231	100.0	375	162.45
20	8.66	73	31.62	126	54.58	179	77.53	232	100.49	380	164.61
21	9.09	74	32.05	127	55.01	180	77.97	233	100.93	385	166.78
22	9.53	75	32.48	128	55.44	181	78.40	234	101.36	390	168.94
23	9.96	76	32.92	129	55.88	182	78.84	235	101.70	395	171.11
24	10.39	77	33.35	130	56.31	183	79.27	236	102.23	400	173.27
25	10.82	78	33.78	131	56.74	184	79.70	237	102.66	425	184.10
26	11.26	79	34.21	132	57.18	185	80.14	238	103.09	450	195.0
27	11.69	80	34.65	133	57.61	186	80.57	239	103.53	475	205.77
28	12.12	81	35.08	134	58.04	187	81.0	240	103.96	500	216.58
29	12.55	82	35.52	135	58.48	188	81.43	241	104.39	525	227.42
30	12.99	83	35.95	136	58.91	189	81.87	242	104.83	550	238.25
31	13 42	84	36.39	137	59.34	190	82.30	243	105.26	575	249.09
32	13.86	85	36.82	138	59.77	191	82.73	244	105.69	600	259.90
33	14.29	86	37.25	139	60.21	192	83.17	245	106.13	625	270.73
34	14.72	87	37.68	140	60 64	193	83.60	246	106.56	650	281.56
35	15.16	88	38.12	141	61.07	194	84.03	247	106.99	675	292.40
36	15.59	89	38.55	142	61.51	195	84.47	248	107.43	700	303.22
37	16.02	90	39.08	143	61.94	196	84.90	249	107.86	725	314.05
38	16.45	91	39.42	144	62.37	197	85 33	250	108.29	750	324.88
39	16.89	92	39.85	145	62.81	198	85.76	251	108.73	775	335.72
40	17.32	93	40.28	146	63.24	199	86.20	252	109.16	800	346.54
41	17.75	94	40.72	147	63.67	200	86.63	253	109.59	825	357.37
42	18.19	95	41.15	148	64.10	201	87.07	254	110.03	850	368.20
43	18.62	96	41.58	149	64.54	202	87.50	255	110.46	875	379.03
44	19.05	97	42.01	150	64.97	203	87.93	256	110.89	900	389.86
45	19.49	98	42.45	151	65.40	204	88.36	257	111.32	925	400.70
46	19.92	99	42.88	152	65.84	205	88.80	258	111.76	950	411.54
47	20.35	100	43.31	153	66.27	206	89.21	259	112.19	975	422.35
48	20.79	101	43.75	154	66.70	207	89.66	260	112.62	1000	433.18
49	21:22	102	44.18	155	67.14	208	90.10	261	113.06	1500	649.7
50	21.65	103	44.61	156	67.57	209	90.53	262	113.49	2000	866.3
51	22.09	104	45.05	157	68.0	210	90.96	270	116.98	3000	1299.5
52	22.52	105	45.48	158	68.43	211	91.39	275	119.12		
53	22.95	106	45.91	159	68.87	212	91.83	280	121.29		

HORSEPOWER REQUIRED TO RAISE WATER

$$\text{Theoretical H.P.} = \frac{\text{G.P.M.} \times \text{Head in Feet}}{3960}$$

		HEAD IN FEET												
	Ft.	10	15	20	25	30	35	40	45	50	60	75	90	100
Gallons per minute	10	.03	.04	.05	06	.08	.09	.10	.11	.13	.15	.19	.23	.25
	15	.04	.06	.08	.09	.11	.13	.15	.17	.19	.23	.28	.34	.38
	20	.05	.08	.10	.13	.15	.18	.20	.22	.25	.30	.38	.45	.50
	25	.06	.10	.13	.16	.19	.22	.25	.28	.32	.38	.47	.57	.68
	30	.08	.11	.15	.19	.23	.26	.30	.34	.38	.45	.57	.68	.75
	35	.09	.13	.18	.22	26	.31	.35	.40	.44	.53	.66	.80	.88
	40	.10	.15	.20	.25	.30	.35	.40	.45	.50	.61	.76	.91	1.01
	45	.11	17	.23	.28	34	.40	.45	.51	.57	.68	.85	1.02	1.14
	50	.13	.19	.25	.32	.38	.44	.50	.57	.63	.76	.95	1.14	1.26
	60	.15	.23	.30	.38	.46	.53	.61	.68	.76	.91	1.14	1.36	1.52
	75	.19	.28	.38	.47	.57	.66	.76	85	.95	1.14	1.42	1.70	1.89
	90	23	.34	.45	.57	.68	.80	.91	1.02	1.14	1.36	1.70	2.04	2.27
	100	.25	.38	.50	63	.76	.88	1.01	1.14	1.26	1 51	1.89	2.27	2.52
	125	.32	.47	.63	.79	.97	1.10	1.26	1.42	1.58	1.89	1.37	2.84	3.16
	150	.38	.57	.76	.95	1.14	1.32	1.52	1.70	1.89	2.27	2.84	3.41	3.79
	175	.44	.66	.88	1.10	1.32	1.54	1.78	1.99	2.21	2.65	3.31	3.98	4.42
	200	.50	.76	1 01	1.26	1.52	1.77	2.02	2.27	2.52	3 03	3.79	4.54	5.05
	250	.63	.95	1.26	1.58	1.90	2.20	2.52	2.84	3.16	3.79	4.73	5.68	6.31
	300	.76	1.14	1.51	1.90	2.27	2.65	3.03	3.41	3.79	4.54	5.68	6.82	7.58
	350	.88	1.33	1.77	2.21	2.65	3.09	3.54	3.98	4.42	5.30	6.62	7.95	8.84
	400	1.01	1.52	2.02	2.52	3.03	3.53	4.04	4.55	5.05	6.06	7.57	9.09	10.10
	500	1.26	1.90	2.52	3.16	3 78	4.42	5.05	5.69	6.31	7 58	9.47	11.36	12.63
	550	1.39	2.08	2.78	3.47	4.17	4.86	5 56	6.26	6.94	8.33	10.42	12.50	13.89
	600	1.52	2.28	3.03	3.79	4.55	5.30	6.06	6.82	7.58	9.09	11.36	13.64	15.15
	650	1.64	2.47	3.28	4.10	4.93	5.75	6.56	7.39	8.21	9.85	12.31	14.77	16.41
	700	1.77	2.65	3.54	4.42	5.30	6.19	7.07	7.96	8.84	10.60	13.26	15.91	17.68
	750	1.89	2.85	3.79	4.74	5.68	6 63	7 58	8.53	9.47	11.36	14.20	17.04	18.94
	800	2.02	3.04	4.04	5.05	6.06	7.07	8.08	9.10	10.10	12.12	15.15	18.18	20.20
	850	2.15	3.23	4 29	5.37	6.44	7.51	8.58	9.67	10.73	12.87	16.10	19.32	21.46
	900	2.27	3.42	4.54	5.68	6.82	7.95	9.09	10.24	11:36	13 63	17.04	20.45	22.73
	950	2.40	3.60	4 80	6.00	7.20	8.40	9.60	10.80	11.99	14.39	17.99	21.59	23.99
	1000	2.52	3.79	5.05	6 31	7.58	8.84	10.10	11.36	12.63	15 15	18.94	22.73	25.25
	2000	5.05	7.57	10 10	12.63	15.15	17.67	20.20	22.72	25.25	30.30	37.87	45.45	50.50
	3000	7.57	11.37	15.15	18.94	22.72	26.51	30.30	34.09	37.88	45.45	56.81	68.18	75.75
	4000	10.10	15.16	20.20	25 25	30 30	35.35	40 40	45.45	50.50	60.60	75.75	90.90	101.01

NOTE:—to get the BRAKE HORSEPOWER required by the pump use the following formula:—

$$\text{Brake Horsepower} = \frac{\text{G, P. M. x Head in Feet}}{\text{3960 x Effy. of the pump}}$$

HORSEPOWER, KILOWATTS, B.T.U., ETC.

1 kilowatt = 1,000 watts.
1 kilowatt = 1.34 H.P.
1 kilowatt = 44,257 foot-pounds per minute.
1 kilowatt = 56.87 British thermal units (B.t.u.) per minute.
1 horse power = 746 watts.
1 horse power = 33,000 foot-pounds per minute.
1 horse power = 42.41 British thermal units (B.t.u.) per minute.
1 British thermal unit (B.t.u.) = 778 foot-pounds.
1 British thermal unit (B.t.u.) = 0.2930 watt-hour.
1 Kilogram-meter = 7.233 foot-pounds.
1 Foot-pound = 0.1383 kilogram-meter.
1 Metric horse power = 0.986 horse power.
1 Horse power = 1.014 metric horse power.

MAN POWER AND HORSE POWER

The standard "horsepower" of 550 foot-pounds per second was intended by its originator to represent the power a horse could exert through an 8-hour day. Apparently the horses used in the tests from which the unit was established were above average strength, for it is now commonly considered that the average work horse can not do better than about 400 foot-pounds per second through an 8-hour day. However, in English speaking countries, the term "horsepower" always means 550 foot-pounds per second (= 33,000 foot-pounds per minute. There are variations in certain other countries.

"Manpower" has no exact mathematical, rating. In fact, it is decidedly indefinite, due to the tremendous variations in personal physical strength, the difficulty of establishing any reasonable average, and also because the number of foot-pounds per second which a man can exert varies greatly with the kind of work. It has been stated that a man rowing a boat can work at a rate of 4,000 foot-pounds per minute, while the same man turning a handle can do only 2,600 foot-pounds per minute. It has also been said that for a very brief interval a man can perform at a rate of one horsepower (33,000 foot-pounds per minute), but this seems doubtful.

A recently published table of man power is as follows:

Very short period, one minute or less..........	⅓ H.P.
Short period, 5 to 10 minutes.................	1/5 H.P.
Short day, 8 hours...........................	⅛ H.P.
Long day, 10 hours...........................	1/15 H.P.

LAND MEASURE

A Quarter Section of 160 Acres Divided to Show Relationship of Rods, Chains and Feet

A rod is 16½ feet.

A chain is 66 feet or 4 rods.

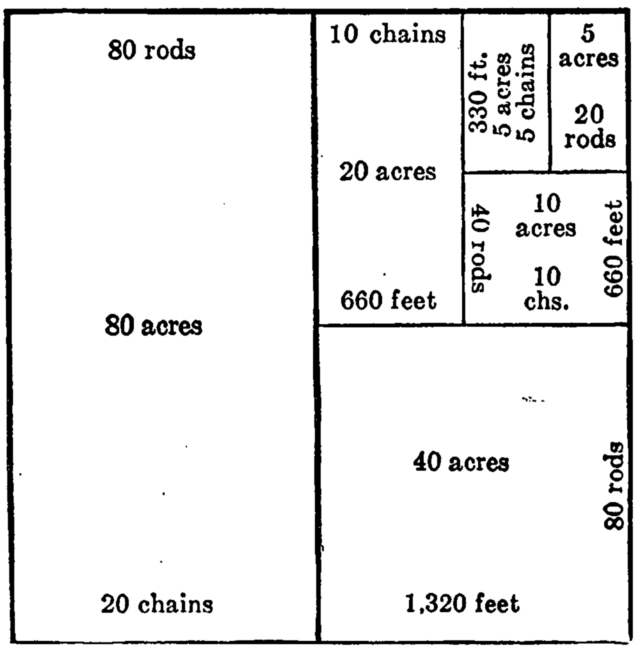
A mile is 320 rods, 80 chains or 5,280 ft.

A square rod is 272¼ square feet.

An acre contains 43,560 square feet.

An acre contains 160 square rods.

An acre is about 208¾ feet square.



LEAKS COST MONEY AND WASTE VALUABLE COMPRESSOR CAPACITY

Courtesy of Ingersoll-Rand

Nothing impresses the average person so much as money, and the column showing the direct money loss should cause many a heretofore unnoticed leak to be repaired.

Size of Opening	AIR*		STEAM**		WATER†	
	No. of cu. ft. wasted per month 100 lbs. pressure	Total cost of waste per month at 6c per 1000 cu. ft.	No. of lbs. wasted per month 100 lbs. pressure	Total cost of waste per month at 60c per 1000 lbs.	No. of gals. wasted per month 40 lbs. pressure	Total cost of waste per month at 15½c per 1000 gals.
⅜"	6,671,890	$400.31	460,000	$276.00	692,400	$108.00
¼"	2,920,840	175 25	203,000	121.80	307,700	48.00
⅛"	740,210	44 41	50,500	30.30	76,900	12.00
1/16"	182,272	10.94	12,750	7.65	19,200	3.00
1/32"	45,508	2.73	3,175	1.91	4,700	0.80

*Based on nozzle coefficient of .65. **Based on nozzle coefficient of .97
†Based on nozzle coefficient of .60.